This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Gs- NA- W

HARVARD UNIVERSITY

VE RI TAS

TRANSFERRED TO GEOLOGICAL SCIENCES LIBRARY

LIBRARY

OF THE

Museum of Comparative Zoölogy

TRANSFERRED

TO GEOL. LIB.

TRANSFERRED

TO GEOL. LIB.

With the Compliments of

The Commissioners of the Wisconsin Geological and Natural History Survey.

E. A. BIRGE, Director.

Madison, Wisconsin.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY.

E. A. BIRGE, Ph. D. Sc.D. Director.

BULLETIN NO. XI. ECONOMIC SERIES NO. 7.

PRELIMINARY REPORT

ON THE

Soils and Agricultural Conditions

OF

NORTH CENTRAL WISCONSIN.

BY

SAMUEL WEIDMAN, PH. D.

Geologist, Wisconsin Geological and Natural History Survey.

MADISON, WIS.
PUBLISHED BY THE STATE.
1903.

cd + ~~Sci 2632.120~~
OCT 21 1904
CAMBRIDGE, MASS.

5 The Survey.

Wisconsin Geological and Natural History Survey.

BOARD OF COMMISSIONERS.

Robert M. LaFollette,
Governor of the State.

Charles R. Van Hise, President,
President of the University of Wisconsin.

Charles P. Cary, Vice-President,
State Superintendent of Public Instruction.

Calvert Spensley,
President of the Commissioners of Fisheries.

John J. Davis, Secretary,
President of the Wisconsin Academy of Sciences, Arts, and Letters.

STAFF OF THE SURVEY.

E. A. Birge, Director of the Survey.

S. Weidman, Geologist.
Survey of Central and Northern Wisconsin.

U. S. Grant, Geologist.
Survey of Southwestern Wisconsin.

N. M. Fenneman, Geologist.
Physical Geography of Lake Region.

C. D. Marsh, Biologist.
Biology of Lakes.

L. S. Smith, Civil Engineer.
Survey of Lakes and Rivers.

W. D. Smith, Field Assistant.

E. T. Hancock, Field Assistant.

Consulting Geologist.

T. C. Chamberlin, Pleistocene Geology.

MUS. COMP. ZOOL.
LIBRARY
MAR 12 1958
HARVARD
UNIVERSITY

Transferred from Widener

TABLE OF CONTENTS.

PAGE

TABLE OF CONTENTS iii

ILLUSTRATIONS v

INTRODUCTION vii

CHAPTER I LOCATION AND GENERAL TOPOGRAPHIC AND GEOLOGIC FEATURES 1–12

- Location and extent 1
- Topography 1
  - Slope and general features 1
  - Hills 2
  - Rivers and valleys 2
  - Lakes and swamps 3
- Geology 4
  - Crystalline rocks 4
  - Potsdam sandstone 5
  - Glacial drift 5
  - Alluvial deposits 6
  - Absence of limestone 7
  - Rock and mineral supplies 7
  - Water supply 8
    - Ground water 8
    - Changes in ground water level 8
    - Character of the well water 8
    - Wells in the alluvial sand and gravel 9
    - Wells in the glacial drift 9
    - Wells in the Potsdam sandstone 9
    - Wells in the crystalline rock 9
    - Absence of artesian wells 11
    - Water powers 12

PAGE.
CHAPTER II. GENERAL CHARACTER AND ORIGIN OF SOIL AND DESCRIPTIONS OF THE SOIL FORMATIONS............ 13-48
Origin of soil.. 13
Surface soil and sub-soil.................................. 15
Basis of classification.................................... 15
Chemical composition of the soil.......................... 16
Wisconsin River sandy soil 17-20
Bancroft gravelly sandy loam................................ 20-22
Antigo gravelly loam 22-24
Amherst sandy loam 25-28
Chelsea clay loam.. 28-30
Cary sandy loam... 30-32
Mentor loamy sand.. 32-33
Kennan clay loam... 33-35
Harrison sandy gravelly soil................................. 35-36
Colby loamy clay.. 36-39
Marathon loam... 39-43
Mosinee gravelly soil 43-44
Ackley gravelly clay.. 44-45
Swamp and marsh soils....................................... 45-48

CHAPTER III. CLIMATE AND PRECIPITATION, HISTORY AND AGRICULTURAL CONDITIONS 49-64
Climate and rainfall 49-56
Temperature.. 49
Rainfall... 52
Killing frosts... 55
History 56-58
First settlements.. 57
First railroads... 57
Increase in population...................................... 57
Condition of agriculture..................................... 58-64
Proportion of cultivated and uncultivated lands 58
Farm buildings 59
Price of farm lands.. 60
Live stock and animal products............................. 61
Crops 61
Transportation and communication 63
Local markets.. 63
Forest condition... 64
INDEX 65-68

ILLUSTRATIONS.

PLATE		PAGE
I.	Soil map of North Central Wisconsin.	In pocket.
II.	Sketch map of Wisconsin showing location of area mapped.	2
III.	Map of vicinity of Antigo	22
IV.	Fig. 1. View of the surface of the Antigo gravelly loam... Fig. 2. Vertical section of soil of the Antigo gravelly loam.	24
V.	Fig. 1. View of surface of Amherst sandy loam Fig. 2. Vertical section of soil of the Chelsea clay loam...	26
VI.	Fig. 1. View of the Marathon loam Fig. 2. Vertical section of soil of Marathon loam	40
VII.	Climatic map of Wisconsin for spring	54
VIII.	Climatic map of Wisconsin for summer	54
IX.	Climatic map of Wisconsin for autumn	54
X.	Climatic map of Wisconsin for winter	54

INTRODUCTION.

The present very general and brief account of the soils and agricultural conditions of North Central Wisconsin, is presented in answer to numerous requests for information concerning the soils of the northern part of the state. It is the outcome of a geological study of the district,[1] rather than a survey of the soils alone by a specialist trained in agricultural science. It is mainly based on a study of the surface formations of the district, which occur in considerable variety and include glacial drift formations of different ages, alluvial formations along the large streams and adjacent to extinct glaciers, and residual formations due to the weathering in place of the crystalline rocks and the sandstone of the district. Each of the surface formations has a characteristic soil and these are described with respect to area, general character and origin, surface features, groundwater, the forest growth developed upon them in the past, and the crops now grown upon them so far as they have been opened to agriculture.

Chapter I, on the topographic and geologic features of the district, and Chapter II, on the soils, and the map of soils, are based almost entirely on the investigations of the writer, while Chapter III, on the climatic conditions, history and agricultural conditions is compiled from various sources as indicated.

Large portions of the several counties, as described in the following pages, are covered with hardwood forests, possess excellent soils, and are rich in agricultural possibilities. Portions also are characterized by soils of inferior quality. It is the purpose of this general report to point out the varying character of the soil throughout the district and the climatic and other surrounding conditions of this part of the state, with the hope that the information given will be not only of value to home seekers, but also to those now engaged in agriculture in the district. It is also hoped that the present report and map will serve as a basis for a more detailed map of the soils of this district, as well as an incentive to a more thorough study of the soils of other parts of our state by those specially trained for this purpose in agricultural science.

---

[1] See forthcoming report on the Geology of North Central Wisconsin.

The writer is indebted to Dr. E. A. Birge, Director of the Survey, for many kindnesses and courtesies shown in the preparation of this report; to Prof. C. R. Van Hise, the Consulting Geologist, for suggestions; to Prof. A. R. Whitson for suggestions and kindly criticism, and to Dr. J. C. Elsom for the several photographic views presented.

A PRELIMINARY REPORT

ON THE

SOILS AND AGRICULTURAL CONDITIONS

OF NORTH CENTRAL WISCONSIN.

CHAPTER I.

LOCATION AND GENERAL TOPOGRAPHIC AND GEOLOGIC FEATURES.

LOCATION AND EXTENT.

The location of the area described in the present very general report is shown by the shaded portions of Wisconsin on the adjoining map, Plate II. The area includes the counties of Portage, Wood, Clark, Marathon, Taylor, and Lincoln, and adjoining portions of Langlade, Price, and Gates. The area contains 199 townships, with an approximate extent of 7,200 square miles, which is about one-eighth the area of the state. The area is considerably larger than that of Connecticut, and a little less than that of New Jersey.

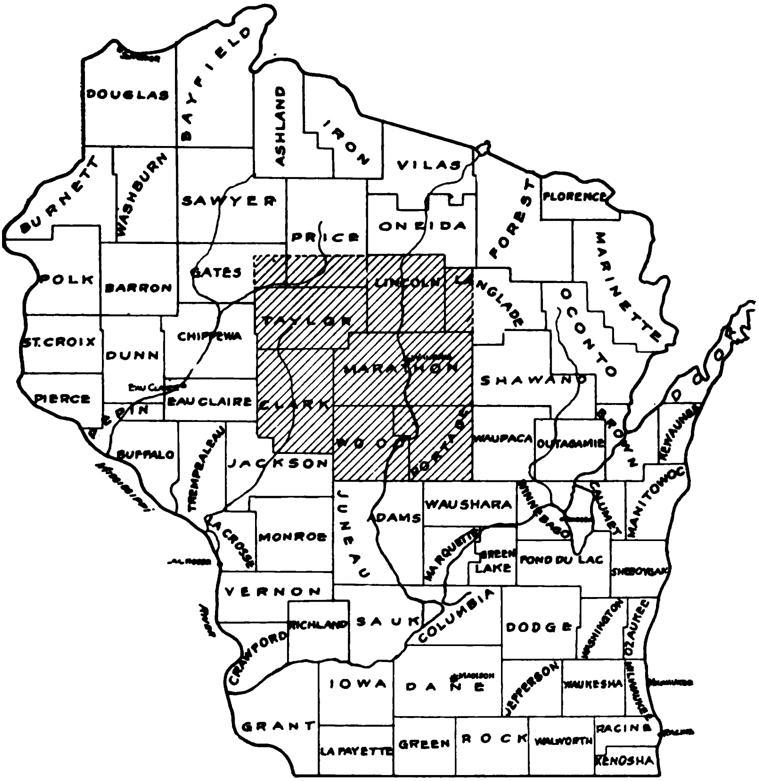
TOPOGRAPHY.

Slope and General Features. The area is an undulating slope rising gradually from the south and southwest. Its southern border has an elevation of 900 to 1,100 feet above sea level, and its northern border an elevation of 1,350 to 1,650 feet. The surface is generally plain-like in southern Clark County, in the southern half of Wood, over a large part of southern and central Portage, and throughout a strip of variable width in Marathon along the Wisconsin River as far north as Wausau. A part of central and southwestern Langlade is also a plain. Outside the area of these plains the surface is a rolling country, with gentle slopes along the valleys and broad slopes over the uplands.

Hills. Throughout the area but few hills reach an elevation exceeding 300 feet above the valley bottoms. Notable exceptions to the lower hills are several elevations a few miles southwest of Wausau, the most prominent of these being the ridge known as Rib Hill, rising 700 feet above its base and 1,942 feet above sea level. In central Wood County, near Arpin, is Powers' Bluff, having a broad base and rising gradually up to 300 or 400 feet above the surrounding lower land. In the plain of southern Wood and Portage and in the more undulating area of western Clark are isolated sandstone mounds that rise from 150 to 250 feet above their surroundings.

A prominent feature of the topography is the belt of bouldery ridges and drift hills, known to geologists as the *terminal moraine,* which trends north and northeast through central Portage and eastern Marathon counties, whence it sweeps in a broad curve about Antigo and then turning to the west passes across northern Langlade and through the middle portions of Lincoln and Taylor counties. This belt of billowy hills and ridges is usually from 6 to 20 miles wide. The undulating hills and depressions constituting the belt generally have a relief of 50 to 100 feet above the surrounding land. In a few places, however, the hummocky hills are much higher, reaching 200 to 300 feet above the adjacent lower land.

Rivers and Valleys. The Wisconsin River flows south through the eastern part of the area. North of Wausau the valley of the Wisconsin is narrow with steep slopes rising from 200 to 300 feet above the river. South of Wausau the valley



SKETCH MAP OF WISCONSIN.
Showing the location of the area mapped.

bottom is broad, with gentle slopes reaching to the uplands above. These uplands along the Wisconsin drop lower and lower towards the south until they merge into the low lying plain of southern Wood and Portage counties.

The principal rivers flowing into the Wisconsin from the east are the Plover in Portage, Eau Claire and Trapp in Marathon, and the Pine and Prairie in Lincoln. Flowing from the west are Mill Creek in Wood, Little Eau Pleine, Big Eau Pleine and Big Rib rivers in Marathon, and the Copper, Newwood, Spirit, Somo, and Tomahawk rivers in Lincoln. In western Wood is the Yellow River, flowing south and joining the Wisconsin in Juneau County. On the east of the Wisconsin River the Plover and Prairie have insignificant valleys, while the Eau Claire, Trapp and Pine for long distances from the Wisconsin have pronounced valleys with long slopes leading to the uplands above. On the west in a similar manner, Mill Creek in Wood and the rivers in Lincoln have shallow valleys, while the Little and Big Eau Pleine and Big Rib rivers in Marathon have deep valleys throughout the larger part of their courses. In general, therefore, the valleys are deeper and the country more rolling in Marathon than in the counties either to the north or to the south. With very few exceptions, however, are the valley or hill slopes too steep for cultivation.

The Black R[illegible]s south from the southern part of Taylor through central Clark. From Medford to Neillsville it has a narrow valley generally from 100 to 200 feet below the surrounding uplands, and with slopes rarely too steep for cultivation. In northwestern Taylor and southern Price are the Yellow and Jump rivers flowing southwest to the Chippewa River. A great part of Clark County, like Marathon, is more rolling than the country either to the south or to the north.

Lakes and Swamps. The portion of the area containing lakes and swamps, as shown on the map, (Plate I, in pocket) is mainly confined to the eastern half of Portage and eastern Marathon, northern Langlade, and northeastern Lincoln counties, and in the vicinity of the terminal moraine of the northwestern part of the area in Taylor County. The swamps associated with the lakes in the above designated parts of the area are generally small and lie in depressions surrounded by the bouldery hills of the vicinity. They are, or were formerly, stocked with tamarack and cedar.

A type of swamp quite different from the above occurs in southwestern Portage and southern Wood counties, which is not associated with any lakes or ponds. Here the swampy areas are broad marshy lands many square miles in extent, and were originally stocked with scattered tamarack. These marshy tracts are approximately at the same level as the adjacent dryer and drained land along the rivers and streams flowing through them.

GEOLOGY.

The rock formations of the area may be grouped into four geologic divisions, as follows:

1. Crystalline Rocks.
2. Potsdam Sandstone.
3. Glacial Drift.
4. Alluvial or River Deposits.

1. *Crystalline Rocks.* The first group includes a number of different kinds of rock, principally granite, quartz-syenite, rhyolite, greenstone or trap rock, mica-sc [illegible] zite, slate, and conglomerate. The granites constitute about 75 per cent. of the crystalline formation. The greenstone, rhyolite, schist, slate, quartzite, and conglomerate have a relative abundance in the order named. These various rocks generally stand on edge and form irregular belts and areas throughout the region. This group of rocks lies near and at the surface in southern Lincoln, large portions of Marathon, and northern Portage and Wood counties.

Over the whole of the area, however, the crystalline rocks occur in isolated patches and along the river beds. The crystalline rocks, with the exception of the quartzite, consist of an abundance of clay producing minerals and hence, where the crystalline rocks occur at the surface, soils of the loam or clay type have developed from and overlie them.

2. *Potsdam Sandstone.* The sandstone formation is an abundant surface rock in Portage, Wood and southwestern part of Clark counties. It also lies beneath the drift in small areas in northeastern Clark, western Marathon and southwestern Taylor. The sandstone lies in horizontal beds upon the crystalline rock, which fact is readily seen in all cases where the two formations crop out together or where wells penetrate both. The sandstone is very generally a soft friable stone and therefore readily crumbles. In places it contains some clayey layers. Where the sandstone forms the abundant surface rock light sandy soils prevail, but where it is overlain with glacial drift the soil assumes the loamy character of the drift covering.

3. *Glacial Drift.* The glacial drift is composed of a heterogeneous loose mass of ground-up rock containing varying proportions of clay, sand, gravel, and boulders. The drift has a very irregular thickness throughout the area and was deposited upon the older formations of crystalline rock and sandstone by the several successive continental ice sheets which extended over this area, and over the adjacent parts of the state and of northern United States. Between each of the successive periods of glaciation long interglacial periods elapsed, and hence there is a wide difference in the age of the several drift sheets covering the area. In a striking manner, through the action of weathering processes such as freezing and thawing, the percolation of the rains and groundwater, and the chemical alteration of minerals and rocks, the earlier drift formations have become more compact and consolidated and contain a larger proportion of clay and fewer boulders than the later drift. Another important dissimilarity is in the surface features of the old and new drifts, brought about by the difference in erosion of the surface of the drift by streams and rains, whereby the older deposits, having been subjected to a long period of erosion, have come to have long gentle drainage slopes and prominent river valleys, whereas the newer drift sub-

jected to a shorter period of erosion is still characterized by belts of steep drift hills, bouldery "hogsback" ridges, shallow valleys, lakes, cedar swamps, and depressions. The soil conditions of the old and new drifts therefore essentially differ from one another and are classified accordingly.

The old drift lies in western and northern Marathon and adjoining portions of Lincoln and Langlade, southern Taylor, most of Clark and a large portion of northern Wood. The old drift generally varies in thickness from 5 to 50 feet. In certain places between Neillsville and Marshfield it has a thickness of over 150 feet.

The new drift lies in the eastern half of Portage County, in the vicinity of and east of the Plover River in Marathon, in northern Langlade, over a large part of Lincoln, northern Taylor, northeastern Gates and southern Price. Outside the area of this map it extends over the whole of eastern and northern Wisconsin. It has a much greater thickness in general than the old drift and usually varies from 50 to 200 feet in depth while in many places along the terminal moraine it probably exceeds 300 feet.

4. *Alluvial Deposits.* The deposits made by rivers in times of flood consist of gravel, sand, and clay. The alluvial deposits are the low and nearly level lands lying along many of the large rivers of the area. During the closing stages of the last glacial period when the great ice fields to the north and east were gradually melting, the rivers that issued from them were unusually swollen, and hence were able to carry and deposit large amounts of gravel and fine sediment along their courses. In this manner broad sandy and gravelly plains were built up along the Wisconsin River and some of its tributaries. These alluvial plains cover most of southern Wood County and southwestern Portage and a broad belt along the Wisconsin River through central Portage and as far north as Wausau in Marathon.

Deposits of alluvium were also built up adjacent to certain portions of the margin of the ice by glacial streams where no large rivers now exist. Such alluvial deposits occur along the terminal moraine in Portage County and in the vicinity of Antigo in Langlade County.

Absence of Limestone. No limestone rock occurs within the area described. The nearest occurrence of the limestone formation is from 10 to 20 miles southeast of Portage County and about the same distance southwest of Wood County.

Rock and Mineral Supplies. The various rock formations of the area furnish valuable deposits. The granite, a few miles north and northeast of Wausau, furnishes first class stone for monuments and building purposes. The sandstone formation in Portage, Wood and Clark counties supply building stone for all local uses. In the northern part of the area the local building stone is supplied in part by glacial boulders and in part from quarries in the granite and schist formations. Common brick clays are abundantly distributed throughout the area in the drift formations and also in the weathered and decomposed portion of the crystalline shales and schists. The quarries and brickyards are located upon the map (Plate I, in pocket). Good road material is abundantly supplied by the boulders and gravel of the drift formation, and from the numerous outcrops of trap rocks, or greenstone, and other crystalline rock of the region. The medium to coarse grained granite is often disintegrated to depths varying from 2 to 10 feet, and this disintegrated or "rotten" granite is often used for road making. The disintegrated granite consists of angular crystals of quartz and feldspar, which readily pack into a hard, compact mass well adapted to the wear of ordinary traffic. Marl occurs in several of the lake beds of eastern Portage County. Peat is found in considerable abundance in the marshy portions of southern Wood and Portage counties and also in many of the swamps of the northern part of the area. The marl and peat though not used at present will undoubtedly be of value in the future.

WATER SUPPLY.

The numerous streams of the area afford abundant supplies of water for stock. For most domestic purposes, however, wells are the main reliance.

The Ground Water. Well water is found at various depths below the surface, depending upon the slope of the land surface and the rock formations beneath. At certain depths below the surface all the pores and fissures of the rock formations are filled with ground water and it is into this water-filled portion of the ground that wells must be sunk in order to obtain an abundant and constant supply. The upper surface of the ground water, generally called the ground water level, is usually very near the level of the streams and lakes of the vicinity. The level of the ground water is not horizontal, but is undulating, the undulations approaching, in a general way, the contours of the land surface, standing at greater depths below the surface in the hills than in the valleys.

Changes in the Level of the Ground Water. The position of the ground water level changes from season to season, standing lower in the winter, when precipitation is slight, and higher in summer, when the rainfall is more abundant. It gradually sinks also from year to year, as the lands have come under cultivation. Some parts of the area show a much greater change in the ground water level than other parts of the area. In the rolling lands of Marathon County where the crystalline rock is at and near the surface but little if any change has taken place. In the area where the wells are in the thick drift, as in Clark County, the ground water has sunk from 10 to 15 feet. In the porous alluvial subsoil of the Bancroft gravelly loam about Almond in southeastern Portage County the water table has sunk from 20 to 40 feet.

Character of the Well Water. The well water throughout the area is that kind known in domestic economy as "soft water." This is due to the absence of limestone in the area.

Abundant well water is obtained in each of the four groups of geological formations, and will be only briefly discussed here as the conditions of the soil water and ground water are more fully described for each of the soil formations.

Wells in the Alluvial Sand and Gravel. The securing of well water in the alluvial formation bordering the Wisconsin River, over a large part of southern Wood, in southwestern Portage, and the vicinity of Antigo in Langlade, is a very simple matter, for this formation consisting of much gravel and sand, is very porous and the level of ground water is generally 10 to 20 feet from the surface, and very often even less than 10 feet. As a rule, however, in order to secure good pure water wells should obtain their supply at least more than 20 feet below the surface and where the ground water is higher than this either "drive wells" or drilled wells should be made. In the vicinity of Almond and farther north in Portage County many of the wells are from 60 to 100 feet deep.

Wells in the Glacial Drift. Water is found at various depths in the sand and gravel of the glacial drift. In the region of the thick terminal moraines where the drift forms ridges the wells generally penetrate nearly to the level of the surrounding lower lands. Where the drift is less than 50 feet thick, unless the land is very gently sloping, the supply of water is usually obtained at the junction with, or a few feet into, the underlying formation, which may be either the crystalline rock or the sandstone. It is very common to find an abundant supply at the junction of the drift with the underlying crystalline formation. However, if water is not struck at the junction it is only necessary to go down into the formation beneath, whether it be the sandstone or the crystalline formation, to find a sufficient supply.

Wells in the Potsdam Sandstone. Wherever the sandstone has a depth of 10 to 20 feet and the land is gently sloping it usually furnishes an ample supply of water. The wells in the sandstone ridges usually reach near to the level of the surrounding lower lands. The wells in the sandstone are almost entirely in Portage, Wood and Clark counties.

Wells in the Crystalline Rock. Wells bottomed in the hard crystalline formation and receiving the whole or a large part of their water supply from the various crystalline rocks are found in all portions of this area. They are especially abundant in the rolling uplands of southern Lincoln, in Marathon, and in northern Portage and Wood counties. The wells generally vary in depth from 20 to 40 feet, depending much as to their location in the hills or in the valleys. The level of the ground water in the crystalline formation seems to closely follow the contours of the land surface, standing high in the hills and near the surface in the valleys. In the crystalline rocks the water passages are confined to the fractures, seams or fissures which are, as a rule, abundant near the surface in the crystalline formations of this state. The statement has been made that it is generally useless to attempt to get a sufficient flow of well water from the crystalline rock, but this statement was based on the erroneous belief that the crystalline formation was generally a massive solid formation and not much fractured or fissured. The crystalline rocks are everywhere quite generally fractured within 50 to 100 feet of the surface and contain an abundance of water and it is only necessary, therefore, to go down into this formation below the level of ground water and open up a number of seams and fissures. The required depth to obtain a sufficient supply of water in the crystalline rock is generally from 20 to 40 feet, as above stated, and only in rare cases is a greater depth than 50 feet necessary. In the thickly settled rolling area about Wausau where the crystalline rock is within a few feet of the surface it is believed that more than one-half the wells are less than 30 feet deep. The much fractured and fissured condition of the crystalline formation holds equally well for those portions of the area covered with the glacial drift and the sandstone, for the fracturing was quite general and took place long before either the glacial drift or the sandstone was deposited. In drilling wells in the hard crystalline rock, like granite, the combined weight of bit and stem should equal 1,200 to 1,400 pounds. The light weight drills usually make slow progress. The possible clogging of the water passages in the process of drilling crystalline rock should be taken into account. In the area where the granite and other crystalline rocks are near the surface, however, most of the wells are dug wells and wisely so for such wells being of large diameter open up a correspondingly greater number of the large, generally nearly vertical, fissures ramifying throughout the formation. The dug wells being of larger diameter have a larger storage capacity and on this account, need not to be so deep as the drilled wells.

Absence of Artesian Wells. The question is often asked as to the possibility of finding artesian wells in this part of the state. In answer to this it may be stated with a considerable degree of certainty that there is very slight possibility of obtaining flowing wells in this area, because the necessary geological conditions are wanting. The widespread occurrence of the granite and other crystalline rocks usually very near to the surface, and generally within striking distance by wells has already been pointed out. It is a well known fact that the crystalline group of rocks does not furnish artesian conditions and no flowing wells have ever been struck in this formation in this state though repeatedly attempted. The structure of the crystalline group, the character of its water passages and source of water is such as to entirely preclude the possibility of obtaining a flowing well from it, no matter how deep the well is sunk.

The sandstone formation lying on top of the crystalline formation, is a principal source of flowing wells in other portions of the state. But where it is the source of flow it lies at a considerable depth below the surface and beneath other thick formations of limestone associated with impervious shales; whereas in this area it either lies at the surface or beneath a variable covering of loose pervious drift. The sandstone of this area, on account of its nearness to the surface, serves as a catchment basin and fountain head for the lower portions of the state, and consequently there is an entire absence of conditions here of fountain flow.

The alluvial formation along the Wisconsin River is porous throughout, and the other conditions for the securing of fountains are wanting. There is a slight possibility of finding an occasional small flow in the hilly portions of the thick drift, but so far as known none such occur in this area.

It may be stated, therefore, with considerable certainty, that the probabilities of securing artesian wells in this area are so small as to make the search for them wholly unjustifiable. The conditions controlling the distribution of the artesian wells in this state are fully and clearly described by Prof. Chamberlin in Chapter VI., Vol. II, Geology of Wisconsin.

Water Powers. The water powers are a prominent and valuable natural resource of the area. No careful and systematic measurement of the water powers of the area has been made, but several estimates have been furnished. Along the Wisconsin River from Tomahawk to Nekoosa no less than fifteen rapids occur, having a fall of from 5 or 10 feet up to 60 feet. Among the more prominent of these, several of which are entirely undeveloped, may be mentioned Tomahawk, Grandmother Falls, Grandfather Falls, Merrill, Brokaw, Wausau, Rothchilds, Mosinee, Stevens Point, Conants, Biron's Mill, Grand Rapids, South Centralia, Port Edwards, and Nekoosa. The amount of available water power in this stretch of river probably exceeds 75,000 horse power, less than one-half of which is at present used. The water powers of the branches of the Wisconsin and other rivers of the area probably exceeds 25,000 horse power. Throughout the area the water powers are readily accessible by rail.

CHAPTER II.

GENERAL CHARACTER AND ORIGIN OF SOIL AND DESCRIPTIONS OF THE SOIL FORMATIONS.

The soils of the area though widely variable in composition and texture readily fall into several well defined classes. In the 7,200 square miles of the area, fourteen kinds or phases of soils were recognized and the area occupied by each shown on the map (Plate I, in pocket) by different colors. It should be borne in mind that these kinds of soils often grade into one another. Between certain soils, however, like the sandy river bottoms and the clayey uplands, the boundary lines are very sharp. Some of the soils are very uniform in character over broad areas while others are quite variable. The gradations and abrupt changes in the soils are pointed out in subsequent pages as each of the various soils is taken up and discussed.

Origin of Soil. It is impossible to adequately discuss the nature of any particular soil without describing the history of its origin and development. If it be understood once for all that all the soils were not made and finished at the same moment in some remote period but that each had a slow development which began at widely different times, and that soils are now actually being formed from day to day, season to season, and year to year, the method of soil growth or its origin is seen at once to be important and a knowledge of it valuable to the agriculturist.

Briefly stated, the soils consist of mineral and organic material. The mineral portions of soils originate through the disintegration and weathering of the stony material and rocks forming the surface of the land and the organic portions through the decay of animal and vegetable matter living upon and within the soil.

The agents most effective in this process of rock weathering which produces the mineral portion of the soil are water in its various forms, change of temperature, and the air. These agents are not only effective at the surface, but they penetrate deeply into the rocks and loose earth. Water in the form of rain acts chemically upon rocks by dissolving them, and mechanically by washing and wearing away the loose material. In temperate climates such as ours the alternate freezing and thawing of the water included in rock pores and crevices, in autumn and spring, tend to loosen and split apart the rocks. Burrowing animals, such as earthworms and the fur bearing animals, aid materially in making soil. The growth of roots of the forest trees and even of the smallest plants split apart the rock particles and assist in soil formation.

As the rocks are being powdered and softened into loose material there is a constant process of wash by rains of this loose soil material from the higher levels on the hill sides to the valley bottoms, and thence by streams to still lower levels on their way to the sea. If the rains are gentle but little loose material is washed away. However, if rains are copious they may transport in a few hours enormous amounts of sand and mud to lower levels. Besides the work of rains and streams in transporting the weathered rocks and soils, wind is also an effective agent in carrying soil particles from place to place.

But perhaps the most important soil transporters in Wisconsin, so far as agriculture is concerned, though now no longer active, were the glaciers of the Great Ice Age. While these ancient glaciers were transporting soil and rock debris, they were also very effective in making the rock and soil particles finer and finer by rubbing and grinding them against one another, and thus were soil builders as well as soil carriers.

As the soils owe their origin to the slow weathering and decomposiiton of the rock formations, some of the soil formations are derived from the weathering of the glacial drift, others by the decay and modification of the various crystalline rocks, of the sandstone, and of the river gravels and sands.

Surface Soil and Subsoil. The surface portion of the soil formation containing more or less dark colored organic material brought to it by the decay of plants is generally from four to eight inches thick. The subsoil lies immediately below the darker surface soil and is the medium in which much of the soil moisture and nitrogen are stored and held available for plant life. If the subsoil texture is such as to hold too little or too much water the fertility of the soil is greatly decreased. It has been shown by Professor King that soil moisture may be obtained through capillary movement at depths of 12 feet below the surface and in some cases at depths of 16 feet. The roots of corn in search of moisture may penetrate the soil to a depth of four feet and the roots of clover often go down 18 inches. Hence it is important for the agriculturist to know the character of the soil for a considerable depth below the surface as well as of that portion which is turned by the plow and the cultivator.

Basis of Classification. Soils are classified in various ways. A grouping of the soils according to the native growth of timber is often used and according to this method the area could be divided into hardwood lands, white pine lands, jack pine lands, and cedar or tamarack lands. A classification according to the kind of crops best grown is often applied and in such cases, potato soils, grass soils, wheat soils, and tobacco soils is used. We also have limestone soils and sandstone soils, a classification based upon the nature of the rock from which the soil is derived.

The classification which seems best fitted to answer all purposes is one based on the texture of the soil, mainly due to the relative proportion of sand and clay present. There is no sharp limit in soils between what is called sand and what is called clay, but these grade insensibly into one another through intermediate grains. If there is more than 95 per cent. of either sand or clay present the surface is best referred to, not as soil, but as sand or clay. Soils are sandy if from 40 to 65 per cent. of their weight is made up of particles so small that from 1,000 to 400,000 of them must be placed in line to span a linear inch, while the balance may be so large that only 20 to 100 of the particles are needed to stretch across the same distance. The heaviest clay soils, on the other hand, may have 80 to 95 per cent. of the small sized particles named above and from 5 to 20 per cent. of the larger grains. Loam soils are intermediate in grain between the sandy soils and the heavy clay soils; while between this medium loam soil and the coarser sandy soil are sandy loams and loamy sands, and between the loam and the clay soils are loamy clays and clayey loams, there being of course, in all cases, a gradual change between the various kinds. If there is present a considerable amount of stone or gravel the soil is called stony or gravelly. Besides these soils there are the muck, peat or humus soils, containing a high percentage of decaying organic matter or humus and occurring in the undrained areas of the swamps and marshes.

Chemical Composition of the Soil. As already pointed out, the kinds of soil and their classification depend upon the texture of the soil rather than the chemical composition. Chemical analyses of soils as usually made, while important, do not usually furnish the information desired to rightly estimate the character of the soil with respect to fertility or its adaptation to certain crops. In general, most soils contain the necessary constituents for the growth of crops; and hence if soils are infertile it is usually because favorable physical conditions are wanting for the development of rich soils, such as the proper conditions of the soil texture, soil moisture, drainage, temperature, rainfall, etc.

The various important chemical elements occurring in soil are oxygen, silicon, carbon, sulphur, hydrogen, chlorine, phosphorous, nitrogen, fluorine, boron, aluminum, calcium, magnesium, potassium, sodium, iron, and manganese. The oxygen, hydrogen, carbon, chlorine, and nitrogen get into the soil from the atmosphere and the rains assisted by vegetation. The other elements are found in abundance in the crystalline rocks of the area as well as in the glacial drift and alluvium made up of crystalline rock debris and in the soils formed by the weathering of these formations. It is believed that the soils of this area contain all the chemical elements necessary for the growth of crops, and that the varying degree of fertility of the different soils is probably due to their texture and the physical conditions surrounding them.

The names adopted for the various soil formations of the area are local and have been selected from the names of rivers or townships where the soils occur.

WISCONSIN RIVER SANDY SOIL.

Area. This sandy loam formation forms the generally level valley bottom of the Wisconsin River and some of its tributaries. Between Wausau and Merrill, as shown by the map, the area of this soil is but a narrow strip along the Wisconsin. South of Wausau the formation spreads out to an average width of six or eight miles and reaching for some distance along the Eau Claire River on the east and the Big Rib on the west. In Portage and Wood counties this soil area is very broad and with the associated marsh lands and peaty soils covers a large portion of southwestern Portage and southern Wood and the adjoining portions of the adjacent counties to the south.

Surface Features. The surface of this soil formation is a nearly level plain, sloping downward to the south along the Wisconsin River. Here and there it is slightly undulating, but usually it is flat with an elevation of 20 to 40 feet above the level of the river. Where the side rivers join with the Wisconsin, lower bottoms or terraces have been formed, reaching for some distance back along these branches. These lower terraces or "benches" are separated from the upper terraces by a steep slope from 10 to 20 feet in height.

General Characted and Origin. As might be expected from the distribution of this soil formation along the rivers, it owes its origin to the accumulation of successive layers of gravel, sand, and silt deposited by the river floods during the glacial period. At that time the streams leading from the margin of the melting ice, a short distance to the east and to the north, were of much greater volume than at present, and hence were able to carry and deposit much coarser sediment than the floods of today. This alluvial formation is generally from 5 to 40 feet thick. The surface soil consists of 5 to 10 per cent. of clay and silt, 5 per cent. of gravel, and the remainder coarse and fine sand. The subsoil consists of alternating layers of gravel and sand, with a very little clay. The mean diameter[1] of the soil grains of the second foot of soil at Nekoosa is .0520 mm.; at Stevens Point, is .0935 mm. and .0920 mm. The mean diameter of two truck subsoils of Maryland, Nos. 471[2] and 563,[3] are respectively .1119 and .0756 mm. In texture and size of grain, this soil is very similar to the Maryland truck soils and to other truck soils of New Jersey and Long Island.

Ground Water. The upper surface of the ground water in this gravelly and sandy subsoil is generally from 5 to 20 feet below the surface. This formation being very porous, the ground water is abundant. At the same time its porous character allows a rapid downward percolation of the rainfall, and hence the soil above the level of ground water readily dries out. Over a large part of this soil formation, however, the level of the ground water is within 2 to 5 feet of the surface, and where this is true, sufficient moisture is generally contributed to the surface soil for the growth of the long rooted crops by means of upward capillary movement. The dug wells in this formation are generally too shallow to supply good water. Where the ground water stands within 20 feet of the surface, drilled wells or drive wells should be made which should penetrate to depths of 25 or 30 feet. By obtaining the supply from greater depths it will not be so likely to be contaminated with surface water.

---

[1] F. H. King, Northern Wisconsin Handbook, p. 44.

[2] Bulletin 21, Maryland Exp. Station, p. 40.

[3] Yearbook, 1894, Dept. of Agriculture, p. 139.

Forest Growth. The forest trees of this formation have been almost wholly removed. This is mainly because they were pine, both Norway and white pine being abundant. There was also a scattering of jack pine in places in the southern part of the area. In the lower benches of river bottom lands along the Wisconsin and other rivers where fine sediment and clay have been deposited, the hardwoods formed an abundant growth.

Crops. This sandy soil is coarse and porous and, as already stated, the rainfall readily sinks into it. It is only in those portions of it, therefore, where the soil contains more than the usual amount of clay, which serves to retain the moisture, or where the ground water stands within 2 to 5 feet of the surface that they can ever become very productive. In general, however, one or the other of these conditions hold for large parts of the area of this soil. The clayey uplands bordering the Wisconsin river in the area north of Portage county furnish more or less clayey wash to this formation. The level of the ground water is never very far from the surface, which, combined with abundant rainfall, usually furnishes sufficient moisture for the growth of special crops.

The prevailing crops grown upon this soil are potatoes, corn, hay, rye, and oats. But little wheat and barley are grown. Potatoes and rye are the principal export crops, the corn, hay, and oats being used for the feed of stock. The common garden vegetables are also grown. As urged by Professor King,[1] these light lands are not well suited to general farming and should be turned to use along special rather than general lines. Clover and peas should be frequently grown in order to furnish a store of nitrogen to the soil. Sufficient live stock should be kept to maintain the proper fertility. These sandy soils are naturally not very rich and any abuse of the tillage will be quickly shown in the crop returns. With proper care and when farmed along special lines as indicated, these sandy lands, readily cleared and tilled, can produce certain crops of excellent quality and in paying quantities.

---

[1] Northern Wisconsin, A Handbook for the Homeseeker, pp. 44–47.

BANCROFT GRAVELLY SANDY LOAM.

Area. The area of this soil formation is wholly within Portage County (see map) and forms a belt of variable width lying west of and adjacent to the prominent ridge of terminal moraine running north and south across the county. This type of soil is well illustrated in the vicinity of Bancroft, Stockton, and Ellis post office.

Surface Features. The surface of this formation is a prairie-like plain, similar to the surface of the Wisconsin River sandy soils and the Antigo gravelly loam.

General Character and Origin. The surface soil is a sandy loam, containing a variable mount of gravel and small pebbles. The subsoil is generally of great thickness. The well section at the depot at Bancroft, on the line of the Chicago & Northwestern Railway, shows the following formation:

Gravelly loam	3 feet
Sand	9 feet
Hard pan (gravel and clay)	3 feet
Sand	12 feet
Gravel, with pebbles 4 to 6 inches thick	3 feet
Sand and fine gravel	68 feet
Total depth of well	98 feet

This formation is an overwash alluvial plain built up in front of the great ice sheet whose edge lay along the eastern border of this soil where the ridge of hilly terminal moraine is located. It was built up by the wash of streams issuing from the melting ice sheet during the Glacial Period. In the northern extension of this soil formation in the vicinity of Hull and Ellis post offices, a greater content of clay is to be noted in the surface soils, which is probably to be attributed to the greater abundance of crystalline rock in that portion of the county. This soil formation grades imperceptibly into the Wisconsin

River sandy soil which lies adjoining it on the west and no sharp line can be drawn separating their areas. With respect to lightness of the surface soil and its content of sand, the Bancroft soil stands half way between the light sandy soils along the Wisconsin River and the gravelly loam of the Antigo formation described in the following pages.

Ground Water. The level of ground water is at variable depth in this formation. About Bancroft the farm wells are from 12 to 20 feet deep. For that portion of this soil lying west of the front ridge of terminal moraine the level of ground water is generally from 8 to 20 feet below the surface. That portion of this formation lying north of Almond, between Almond and Arnott, and between the ridges of bouldery drift hills is at a higher elevation than the area about Bancroft, and hence the level of ground water is farther below the surface, the wells usually having a depth of 60 to 80 feet and in a few instances over 100 feet. The level of ground water in this soil formation in the vicinity of Almond, as previously noted, has sunk from 20 to 40 feet since cultivation of the land began. This lowering of the water level has greatly affected the lakes and ponds of the region, for all of them have shrunk considerably and many have entirely disappeared.

The surface soil, as already stated, contains a variable amount of clay and when the soil is properly manured and tilled it holds sufficient moisture for the growth of most of the common crops.

Forest Growth. The northern extension of this soil formation about Ellis post office, where the soil is not so light, developed a good growth of Norway and white pine and some hardwoods. The lighter soil of the area about Bancroft and Almond developed only a growth of scrub oak and jack pine, with some Norway and white pine.

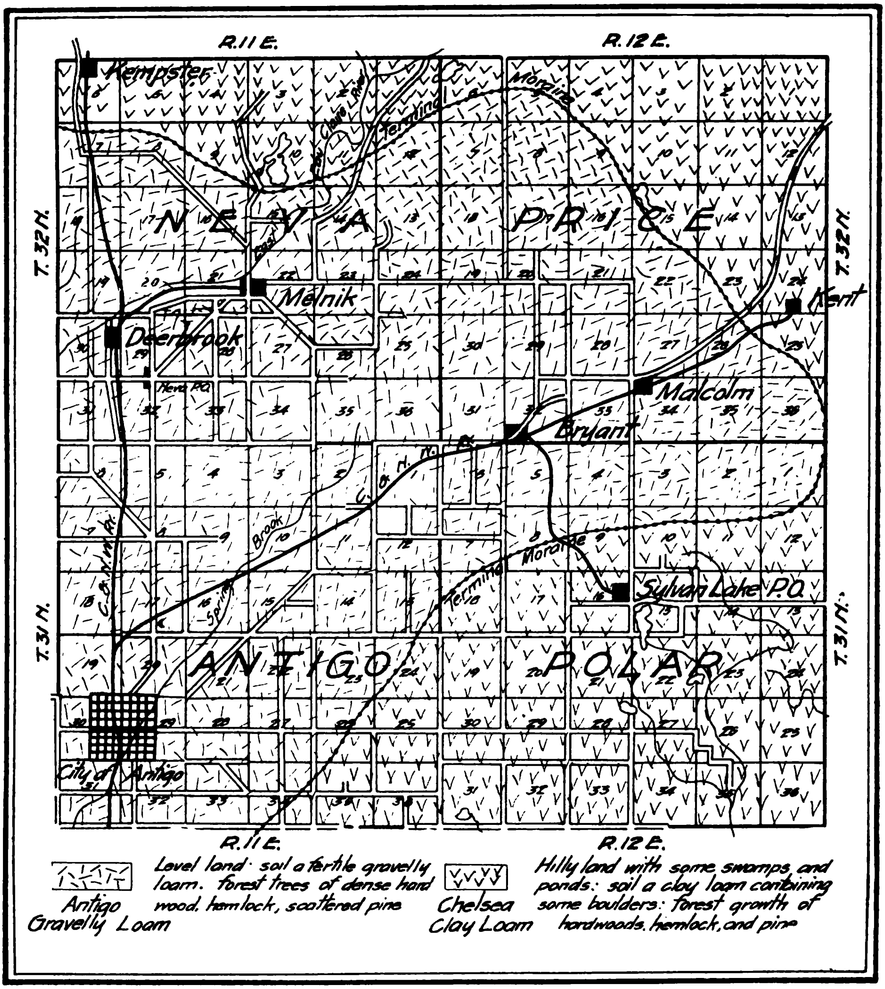
Crops. The prevailing sandy loams of this formation are warm and readily tilled, and are well adapted to the growing of potatoes, vegetables, corn, rye, oats, and clover. Potatoes and rye are the principal export crops. Dairy products and live stock are also leading sources of farm income. Clover is widely grown for the double purpose of fertilizing the soil and for hay. This soil is in every respect well adapted to potato culture, for it is well drained, does not harden on drying, is readily seeded to clover when desired, and responds quickly to manures. The potato is not, nor should it be, made the only farm crop. The wise potato grower should have a part of his land in clover, a part in grain, a part in pasture, and a part in potatoes; in this manner of practicing a rotation of crops the fertility of the farm can be kept at a high standard. About Almond, Bancroft, and Stockton the principal export crop is potatoes. Farther north, where the soil is heavier, the grasses, clover, and grain are raised to good advantage and dairying ranks with potato raising.

ANTIGO GRAVELLY LOAM.

Area. The area of this soil formation, as shown on the map, is in the vicinity of Antigo, the southwestern part of Langlade County. It lies immediately in front, that is, to the west, of the prominent ridge of terminal moraine, which makes a large bend to the east in this vicinity. It is thus bounded on the south, east, and northeast by the ridge of terminal moraine while on its western border is the area of wet land of the western half of the town of Ackley. Because of the eastward extension of this formation beyond the boundaries of the large map, a small map is made on the same scale as the larger map (Plate III) to show the area in full of this formation. This soil formation occurs to a small extent in the vicinity of the terminal moraine in Lincoln and Taylor counties.

Surface Features. The surface of this formation is a prairie-like plain, as shown in Fig. 1, Pl. IV, sloping gently to the south and southwest. Along the Eau Claire River and its branches are shallow valleys and bottoms about 15 to 20 feet below the general surface of the adjacent land and usually one-eighth to one-half a mile wide.

General Character and Origin. This soil consists of clayey and gravelly loam at the surface, underlaid by a subsoil consisting of sand and gravel. The thickness of this soil formation


R. 11 E.
R. 12 E.
T. 32 N.
T. 31 N.
NEVA
PRICE
ANTIGO
POLAR
Kempster
Melnik
Deerbrook
Kent
Malcolm
Bryant
Sylvan Lake P.O.
City of Antigo
Terminal Moraine
Spring Brook
East Branch
C. & N. W. R.R.
Level land: soil a fertile gravelly loam. forest trees of dense hard wood, hemlock, scattered pine
Antigo Gravelly Loam
Hilly land with some swamps and ponds: soil a clay loam containing some boulders: forest growth of hardwoods, hemlock, and pine
Chelsea Clay Loam

SOIL MAP OF VICINITY OF ANTIGO.

Shows the location of the terminal moraine and the area of a portion of Antigo gravelly loam and the Chelsea clay loam.

is considerable, averaging perhaps from 30 to 60 feet for the whole area. At Antigo the thickness is 58 feet to granite, as follows:

Gravelly clay loam	4 feet
Sand and fine gravel, with thin layers of coarse gravel	54 feet
Total	58 feet

The Eau Claire River and its branches, as already mentioned, have cut valleys into this formation from 15 to 30 feet below the general surface, but in only a few places do the valley bottoms reach the rock. This formation generally grows thicker as the ridge of terminal moraine is approached. While the underlying portion of this formation is sand and gravel, the surface soil and the upper part of the subsoil to a depth of 12 to 36 inches contains sufficient clay to give it the properties of a loam, varying from a clayey to a sandy loam, and very generally containing a variable quantity of gravel. The usual size of the largest pebbles range from three to four inches in diameter. A view of this soil formation showing the layers of gravel, sand, and clay is shown in the photograph, Fig. 2, Pl. IV.

The formation is an overwash plain, built up during the last glacial period, and owes its origin to the wash of glacial streams issuing from the edge of the melting ice field, the ice edge being stationed where the ridge of terminal moraine is located. The streams issuing from the glacier were heavily laden with detritus, and flowing out beyond the ice deposited their loads of gravel, sand, silt, and clay. As the ice sheet gradually melted away and grew smaller, the streams issuing from it also grew smaller and weaker and hence a lesser proportion of coarse detritus and a greater proportion of finer and lighter sediment such as clay and silt forms the topmost layer of the formation. The upper portion contains small patches of fine clays, suitable for making brick. Several such clay beds are worked into brick about Antigo. At each of the clay banks the surface soil of 6 or 12 inches has a dark color and contains much humus, and below this there is one and one-half to three feet of clay overlying a considerable thickness of gravel and sand. The gravel of this formation is quite generally of granite and other crystalline rock.

Ground Water. Over a large part of this soil formation the level of ground water generally stands within 8 to 20 feet of the surface. As the hilly land towards the east is approached and the elevation rises, the level of the ground water is at a correspondingly greater distance below the surface. Farmers usually make their wells by driving the common well tubing into the soil and gravel to a depth of 12 to 20 feet. In Antigo the level of ground water is about 16 feet below the surface. Because of the loamy character of the upper three feet of surface and subsoil, a sufficient amount of soil moisture is maintained for the growth of all crops.

Forest Growth. This soil formation has grown an abundant stand of hardwoods, hemlock and white pine, the hardwoods and hemlock prevailing. The hardwoods are elm, maple, basswood, birch, and ash, with some oak. Most of the pine has been cut. The standing hardwoods and hemlock show a dense and healthy growth.

Crops. The soil of this formation is very productive, as attested by the numerous thriving farms established upon it during the short period of the past fifteen or twenty years since the vicinity of Antigo was first settled and farming began. Most of the abundant rainfall of the growing season sinks slowly into the ground to the level of the ground water, which is usually never so far below the surface but what moisture may be readily brought back to the surface by capillarity, as needed. Being of a loamy character, therefore, it does not harden on drying and is well suited to the growth of all farm crops. It is well adapted to the growing of grasses and clover for dairy and stock purposes, of potatoes, barley, oats, rye, peas, corn, rape, and garden vegetables. On the lighter phases of the soil potatoes are an excellent crop, and clover is grown everywhere.

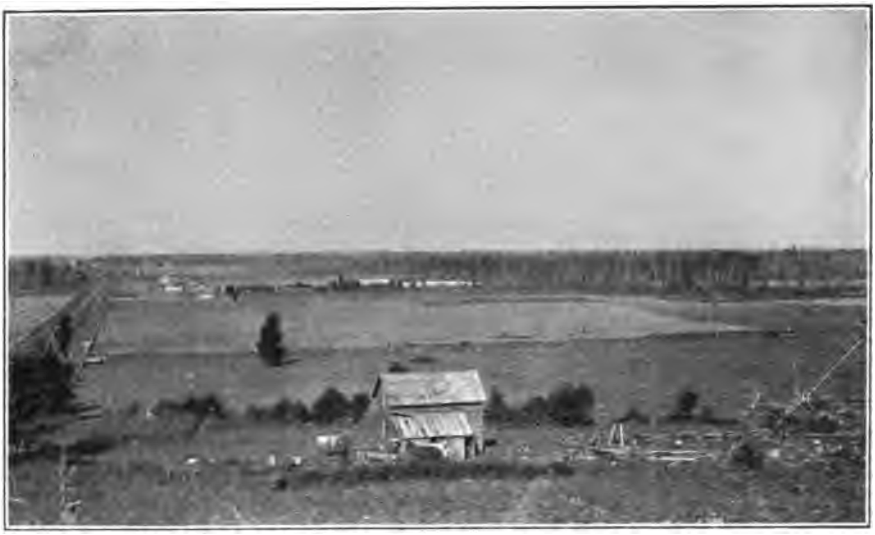


FIG. 1. VIEW ACROSS THE ANTIGO GRAVELLY LOAM. TYPE OF ALLUVIAL SOIL.

View taken five miles northeast of Antigo, Langlade County, shows the nearly level surface characterizing the alluvial soil formations.

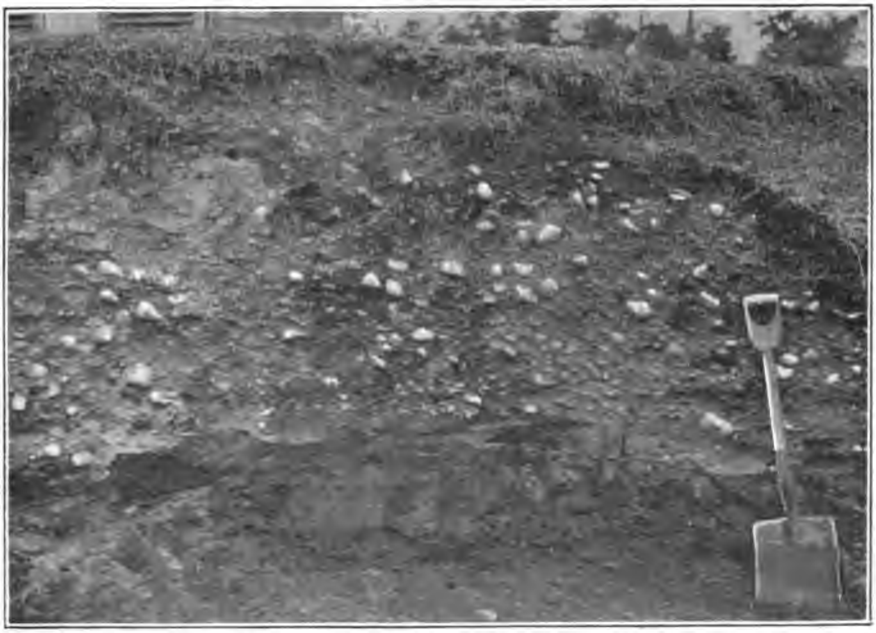


FIG. 2. SECTION OF ANTIGO GRAVELLY LOAM. TYPE OF ALLUVIAL SOIL.

Deerbrook, Langlade County. Upper four feet is clay, sand and gravel, lower two feet is sand and gravel.

AMHERST SANDY LOAM.

Area. This soil formation occurs in the two eastern tiers of townships of Portage County, covering the whole or parts of the towns of Almond, Belmont, Buena Vista, Lanark, Amherst, Stockton, Sharon, and New Hope.

Surface Features. The characteristic feature of the surface of this formation is that of a generally uneven and rolling country throughout. The hills are generally from 50 to 150 feet above the lower lying lands. The country is easily traversible in all directions by wagon roads and railroads. It may be noted that there are narrow belts of this formation, as shown on the map, in the eastern parts of the towns of Almond and western Buena Vista, forming ridges trending north and south. The continuous area of this formation farther east extends for some distance into Waupaca county. This formation, consisting of low steep hills and ridges, constitutes the terminal moraine of the latest drift sheet concerning which a number of references have already been made. This belt of terminal moraine besides being characterized by rather steep ridges and hills also contains numerous basin-like depressions, sometimes having dry bottoms and sometimes containing lakes, ponds, or swamps. Boulders of widely variable size are also a prominent feature of this soil formation.

Along the eastern border of Portage County, north and south of Amherst, steep and abrupt ridges and hills are less common than farther west and in this vicinity are stretches of gently sloping or nearly level land. Over the gently sloping lands the boulders are not abundant. Throughout the area of this formation, however, lakes and swamps abound, which vary from a few acres to over a hundred acres in extent. Among the more prominent lakes may be mentioned Claud's Lake, Lake Emily, and Pickerel Lake.

General Character and Origin. The surface soil of this formation is a sandy loam, varying considerably in the relative amounts of sand and clay. It is a somewhat heavier soil than the Bancroft sandy loam adjoining it, and appreciably lighter than the clayey loams of the morainic and hilly country farther north in eastern Marathon County. In general, it is a sandy loam containing a variable amount of rounded stone and boulders, which vary in size from a few inches to five or six feet in diameter.

This soil formation has its origin in the accumulation of glacial debris upon a generally soft, friable sandstone. Hence the subsoil is the product of ground-up and disintegrated sandstone of the underlying Potsdam formation, with which is combined a plentiful admixture of clay and crystalline boulders carried by the glaciers from the region farther away to the north and northeast.

The surface soils generally consist of four to ten inches of light loam, enriched by a variable amount of organic material. Below this usually lies from one to five feet of brownish clay, mixed with boulders and pebbles. Below the bouldery clay are alternating beds of more or less stratified gravel, sand, and clay, mixed with boulders. The thickness of this formation is very considerable, probably varying between 50 and 200 or 300 feet. About Amherst numerous wells are 50 feet deep without striking rock, and on the summits of the ridges and hills of the terminal moraine wells are often from 100 to 150 feet deep and wholly within this formation. In the vicinity of Alban and Rosholt post offices in the town of Alban are a few wells from 80 to 100 feet deep, striking the granite at bottom.

More or less wash has also taken place in this rolling country, and clayey loams are often found in the bottoms. Boulders are in general not so abundant over the gentle slopes as upon the hills and ridges. Hence the soil throughout varies more or less with the surface features.

Ground Water. As an unvarying rule the surface stratum of clay and boulders immediately underlying the surface soil, known to geologists as "boulder till," is of such thickness and texture as to retain sufficient moisture under the usual conditions of rainfall, for the growth of crops. Water for domestic use, however, is obtained from wells which penetrate this

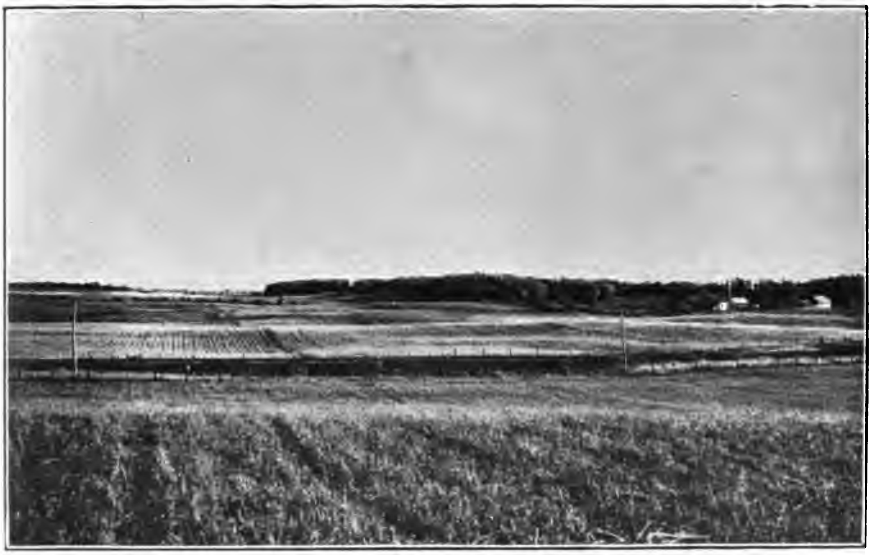


FIG. 1. VIEW OF AMHERST SANDY LOAM. TYPE OF GLACIAL SOIL. One mile east of Arnott, Portage County. View shows rolling surface with depressions characterizing the terminal moraines.

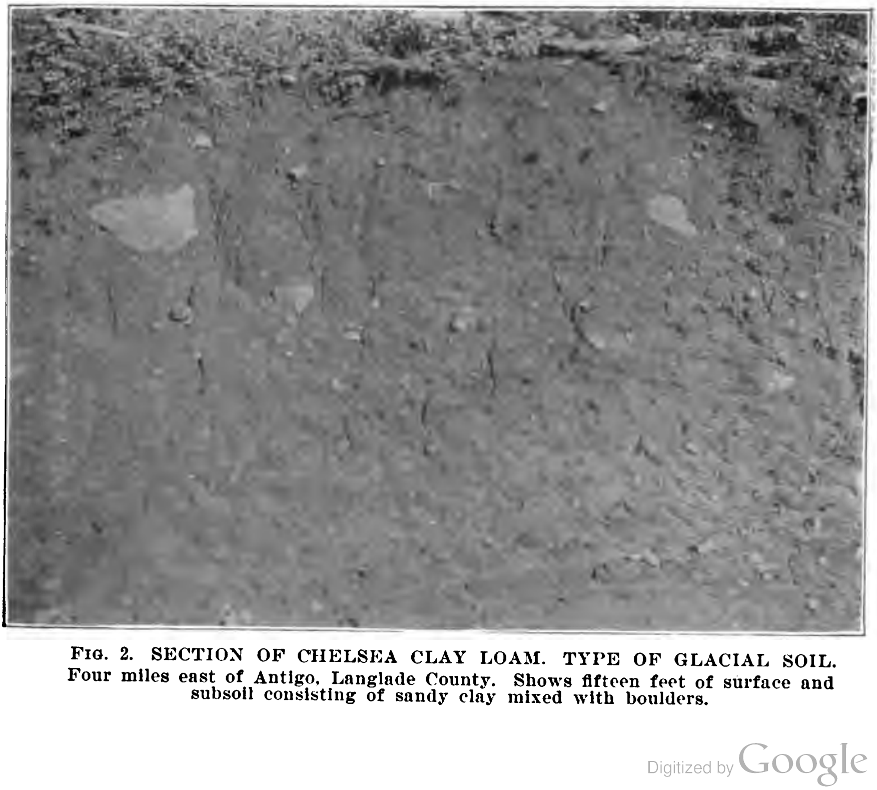


FIG. 2. SECTION OF CHELSEA CLAY LOAM. TYPE OF GLACIAL SOIL. Four miles east of Antigo, Langlade County. Shows fifteen feet of surface and subsoil consisting of sandy clay mixed with boulders.

boulder till, either to the general level of the ground water of the region, or to clayey layers which lie above the general water table but beneath water bearing sand and gravel beds which often abound at varying depths in this drift formation. Under the latter conditions wells immediately adjacent to one another vary considerably in depth. In general, however, the level of ground water must be reached, which is approximately the level of the streams and lakes of the vicinity, in order to obtain a sufficient supply of water. In the higher hills of the belt of terminal moraine wells are often 100 to 150 feet deep, and in the gently sloping lands about 50 feet deep.

Forest Growth. Upon most of this soil formation grows a generally dense growth of scrub oak and scanty poplar, with little or no other hard woods or pine. Only in the northern part of this soil area where the soil becomes heavier does a heavier growth of hard woods and pine prevail. In the northern parts of townships 24, ranges 9 and 10, the red oak becomes appreciably larger and some white oak and pine begin to appear. Upon the clay soil adjacent to the boundary of Portage and Marathon counties along the branches of the Little Wolf River the scrub oak is entirely replaced by a heavy stand of hard woods and hemlock through which was originally sprinkled much pine. But south of the head streams of the Little Wolf where the land is mapped as the Amherst sandy loam, the forest growth, with little exception, as already stated, was a thick growth of scrub oak.

Crops. The sandy loam is good, strong land and capable when properly farmed of being made very productive. Being sandy, it is warm and readily tilled. It is well adapted to the growth of potatoes, corn, oats, rye, grasses, and clovers. The potato is the most important crop. Potatoes and dairy products and stock are the principal exports from the farms. The Amherst loam and the Bancroft sandy soils are pre-eminently the potato soils of Wisconsin, and potatoes grown in them yield a fair average crop per acre and in quality are equal to the best in the country. By a wise rotation in crops of potatoes, corn, small grains, grasses and clover for pasturing stock, thriving farms have been developed. Garden vegetables and small fruits do well, and upon suitable sites in the well drained hilly portions of the area, the hardier varieties of the apple can be grown.

CHELSEA CLAY LOAM.

Area. This soil formation as outlined upon the map lies in the southeastern part of Marathon, northern part of Langlade, and over a large part of Lincoln, northern Taylor, and southern Price counties. This formation, as here defined, also extends over a large portion of the northern part of the state, outside the area of this map.

Surface Features. The surface of this formation is very similar to that of the Amherst sandy loam. A large part of this soil formation is characterized by belts of ridges and billowy hills, and associated with basin-like depressions, swamps, and small lakes or ponds. The belt of hilly land which constitutes the terminal moraine of the latest drift sheet extends across the northern part of the area, whence it sweeps to the eastward about Antigo, thence southwest, and being continuous with the belt of terminal moraine along the western border of the Amherst sandy loam in Portage County. The terminal moraine is a prominent feature of the landscape. The billowy hills and ridges constituting it generally have steep slopes and often rise from 100 to 200 feet above the surrounding lower land. Unusually high portions of it lie a few miles east of Ogema in southeastern Price County, and southeast of Tomahawk in Lincoln County, and in northwestern Langlade County. South of this prominent belt of hills in southeastern Taylor, southern Lincoln, and western Langlade, are narrower belts of similarly shaped hills and ridges, which resemble the billowy and hummocky features of the large moraine, but are very much smaller. These latter hills and ridges are generally within 30 to 50 feet in height, and they mark the border of some of the earlier drift formations. These smaller moraines like the larger one, are associated with depressions, swamps, and ponds, and are plentifully covered with boulders of all sizes.

Outside the areas of terminal moraine, the surface of this formation is gently rolling land, with long gentle slopes and shallow river valleys. A broad area of gently sloping land is in that portion of Lincoln County lying west of the Wisconsin River and north of the New Wood River. A similar broad area of gently sloping land without hills lies north of the terminal moraine in southern Price and northwestern Taylor counties. On the other hand the northeastern part of Lincoln County lying north of the Prairie River and east of the Wisconsin River, and also the northern part of Langlade County, is mostly occupied by the hilly terminal moraine and is characterized by numerous lakes and swamps.

Character and Origin. The surface soils of this formation are clay loams varying to lighter loams. The surface soils are the result of the weathering of glacial debris which consists of a heterogeneous mass of crystalline rock, boulders, gravel, sand, and clay. The upper 5 or 6 feet of the subsoil consists generally of boulder clay, that is, a mixture of clay and boulders, with a variable amount of sand. Beneath the boulder clay is a succession of irregular beds of gravel, sand, and clay, mixed with boulders, having a depth generally varying from 50 to 200 feet. This soil formation is much younger than the Colby loamy clay described in following pages. Its later origin is shown not only by the surface features, such as the undrained lakes and swamps, but also by the presence of numerous disintergrated boulders in the surface soils and by the much less decomposition of the clay producing minerals contained in it. Hence this soil is lighter and more porous than the Colby loamy clay.

In the region of the terminal moraines this soil might well be termed a stony or bouldery loam. This soil formation is generally more stony than any other soil of this area. Over large portions of the area, however, where the lands are gently sloping, boulders are often almost entirely absent. The amount of stones is usually not enough to interfere permanently with cultivation, for they can be removed or so placed that the fields can be plowed without difficulty.

Ground Water. The boulder clay forming the upper surface of this formation is everywhere thick enough to retain sufficient moisture from the rainfall for the growth of all farm crops. Well water must be obtained by penetrating to variable depths through the upper clayey portion of this formation to the underlying sandy and gravelly portion of the loose drift. The depth of the wells vary with their locations on the hills or in the valleys. Wells in this formation are more variable in depth than in any other soil formation of the area.

Forest Growth. The forest growth of this soil was originally very dense and consisted principally of hard woods and hemlock, with scattering white pine. The hard woods are mainly birch and basswood, with much smaller amounts of elm, oak and maple. The amount of hemlock was generally equal to or greater than that of the combined hard woods. The pine has been cut, but large and undisturbed tracts of hemlock still remain. The swamps are stocked with spruce, cedar, and tamarack.

Crops. In all sections where farms have been cleared on the clayey loam of this formation the soil shows itself capable of producing good grain and grasses as well as corn and potatoes. This soil is in general somewhat coarser and more porous than the Colby loamy clays and hence is better suited to corn and potatoes, though not so strong a grass and clover land as the latter. Nevertheless it maintains with ease an excellent dairy and stock industry. A clover rotation with small grains and other crops should be maintained upon it and by a wise selection of farm crops built about a dairy and stock industry, steady income will be insured to the farming communities. Garden truck and small fruits can be grown in abundance, and on the well drained slopes of the hilly belts the hardier fruit trees can be grown with some success.

CARY SANDY LOAM.

Area. This soil, as shown on the map, forms a belt extending east and west across the south-central part of Wood County, and northwest across the southwestern part of Clark County.

It covers the whole, or portions of the towns of Sigel, Seneca, Hansen, Wood, Dexter, Hiles, Cary and Rock in Wood County and Sherwood Forest, Lynn, Washburn, Levis, Pine Valley, Hewitt, Seif, Eaton and Mead in Clark County.

Surface Features. The surface of the area included under this soil formation is gently sloping and rolling throughout. Sandstone hills and mounds are common and here and there are a few low ridges and knobs of granite. Most of the land, however, is not far above the level of the streams, though having in general a sufficient unevenness of surface for good drainage.

General Character and Origin. The surface soil of this area is generally a sandy loam. It, however, is not at all uniform and contains areas of sandy soils and also areas of clayey soils. This soil is appreciably lighter than the Colby loamy clay adjoining it on the north and in turn it is heavier than the light sandy soil prevailing throughout the town of Mentor, Clark County, and the sandy soil along the Wisconsin River.

This soil has its origin in a thin glacial drift covering, in some places, the sandstone and in other places the crystalline rock, or its decomposed equivalent of clay. The drift covering is so thin and irregular that the soil changes rapidly with the changing character of the rock beneath and hence the soil varies from a sandy loam over the sandstone to clayey loams and clay over the crystalline rocks. An accurate detailed map of this sandy loam, here mapped as a single soil formation, would show irregular areas of clayey and sandy soils interspersed throughout a predominating sandy loam formation. The clayey loams prevail over the low lying land while the sandy loams are distributed over the higher slopes where the sandstone outcrops are abundant.

Ground Water. The clayey content of this soil is generally sufficiently abundant to retain the required amount of moisture for the growth of crops. It is only where the soil is very sandy that there is liable to be a lack of sufficient moisture. Wells in this formation generally find water at depth of 10 to 25 feet in the lower areas, and at a correspondingly greater distance on the higher land. Wells on the higher elevations of sandstone generally strike water at the contact with, or very near to, the underlying formation of clay or crystalline rock.

Forest Growth. The forest growth of this soil was originally abundant and consisted of pine and hardwoods. The pine has been wholly cut. The prevailing hardwoods are oak, basswood, maple and elm. Over a large portion of the area the pine and hardwoods were about equally distributed. Over the sandy soils, however, Norway and white pine generally prevailed.

Crops. The prevailing crops are hay, oats, rye, potatoes and corn. The soil, being generally sandy, is warm and readily tilled. Potatoes, dairy products and live stock are the principal exports from the farms.

MENTOR LOAMY SAND.

Area. The area of this formation is in southwestern and southern Clark County, and in irregular patches through the central part of Wood County. This soil formation has a widespread distribution over part of Juneau, Monroe, Jackson, Eau Claire, and Trempealeau counties.

Surface Features. The surface of this formation is gently sloping dotted with mounds of sandstone, some of which are mere swells in the plain-like area, while others are rugged pinnacles or castellated peaks, rising abruptly from 100 to 150 feet above the general surface. Outside the area of this map some of these mounds rise from 200 to 300 feet above their surrounding area. The abrupt peaks are not very numerous, the main surface being occupied by low swells or nearly level stretches of sandy lands.

Character and Origin. The soils of this formation are sandy, containing a variable amount of clay and hence grading into loams. The formation has its origin in the disintegration and weathering of the sandstone with which is mixed a variable but generally very thin covering of glacial drift. The drift consists of loose sand mixed with clay and "hard heads" or boulders. In some instances the drift forms low ridges and knolls in which the drift is from 10 to 20 feet thick. Over a large part of the area, however, sandy subsoils or the sand rock is within a few inches of the surface. The clay content of the drift makes the surface soils appreciably better and hence where the boulders are abundant usually a better soil is present. Clayey loams occur in the low marshy places, probably due to wash of clay from the higher lands.

Ground Water. The open texture of this sandy soil is generally too porous to retain much moisture. Where clay is abundant in the surface soils, better conditions for retaining soil moisture prevail. Over a large portion of the area the level of ground water is from 20 to 40 feet below the surface, and approximately at the level of the streams of the area.

Forest Growth. The forest trees of this soil were mainly pine. The hard woods of merchantable value were scarce. The pine has long since been cut away. Much of this area presents an uninviting aspect of waste lands, here and there showing growths of jack pine and scrub oaks and an abundance of "sweet fern" or "sweet gale," *Merica asplenifolia.*

Crops. In those clayey portions where the glacial drift is several feet in thickness or the lands are low and clay has been washed in, certain crops like corn and potatoes can be grown with success. In general, however, the soils are too light and porous and the ground water too far from the surface to be very productive. Potatoes, corn, rye, buckwheat, beans, garden truck, and small fruits are best adapted to this soil. Clover and peas can be grown in many fields, and where this can be done the land can be made more productive for other crops.

KENNAN CLAY LOAM.

Area. The area of this loam formation, as shown on the map, is located in southeastern Gates, southern Price and northwestern Lincoln counties.

Surface Features. The surface of this formation is gently sloping and rolling with here and there broad nearly level stretches. It contains a few swamps, though entirely free from lakes. The gently sloping surface of this formation is in marked contrast with the hilly land of the Chelsea clay loam adjoining it on the south.

General Character and Origin. The soils of this formation are clay loams varying to lighter loams. Like the Chelsea clay loam the soil is the result of the weathering of glacial debris consisting of a mixture of crystalline rock, gravel, sand, and clay. A variable amount of boulders is often scattered throughout the surface soil though generally not to such an extent as to interfere permanently with cultivation. Over large stretches of the area boulders are almost entirely absent. Geologically considered, this soil formation includes a part of the area of the ground moraine of the latest drift series. As compared with the Chelsea clay loam, it contains much fewer boulders and also differs from the latter in its surface features as above indicated. The general character of this soil resembles very closely the Colby clay loam though in general the latter is a finer grained soil and contains fewer boulders.

Ground Water. The bouldery clay forming the upper portion of this formation is everywhere thick enough to retain sufficient moisture for the growth of all farm crops under ordinary conditions of rainfall. Where the land is very gently sloping, the soil is likely to remain wet for some time after heavy rains, but as adjoining lands are cleared and come under cultivation a more rapid surface drainage will be acquired. Wells in the area of this formation are generally wholly within glacial drift, are from 20 to 40 feet deep and supply an abundance of good water.

Forest Growth. The forest growth of this soil was originally very dense and still remains so over most of the area. The trees were mainly hardwoods and hemlock with scattering white pine. Most of the pine has been cut. The hardwoods are mainly birch and maple, with smaller amounts of elm, basswood and oak. In the wet and swampy portions mixed hardwoods and tamarack abound.

Crops. But a small portion of the area of this soil has passed under cultivation. In all sections where farms have been cleared, the soil shows itself capable of producing good crops of grain and grasses as well as corn and potatoes. The soil is well adapted to the growth of grass and clover and it should maintain, with ease, an excellent dairy and live stock industry. Garden truck and small fruits can be grown in abundance.

HARRISON SANDY GRAVELLY SOIL.

Area. This coarse sandy soil is distributed over the northern part of the towns of Harrison, King and Tomahawk in Lincoln County. The area of this soil formation and the boundary between it and the heavier clayey soils lying immediately south are merely estimated, as only a few roads traverse this entire region. This soil formation is meant to include the light pinery land of northern Lincoln County, which broadens out to the north and covers a large part of Oneida and the adjoining counties.

Surface Features. The surface of this area is uneven with bouldery drift hills alternating rapidly with nearly level stretches of sandy plains. This area contains numerous swamps and lakes.

General Character and Origin. This soil is quite generally very sandy and gravelly, containing a variable though generally small amount of clay. The lower and more level lands are generally uniformly sandy soils, while the hilly lands are bouldery and gravelly mixed with some clay.

Ground Water. This light sandy and gravelly soil is generally too porous to retain much water near the surface, and hence the coarse gravelly soils on the hill sides are generally too dry to be fertile. The lower sandy lands where the level of ground water stands nearer to the surface, are likely to be the most productive.

Forest Growth. The forest trees grown upon this soil were mainly Norway and white pine, most of which has been cut away. In scattered patches over this area, however, pine is still abundant. Scanty growth of hardwoods are scattered over large portions of the area, and here and there, where the soil contains an abundance of clay, dense hardwoods may be found.

Crops. But a small portion of this sandy land has been opened to cultivation. Northeast of Tomahawk, north of the Wisconsin River, where the sandy soil contains a somewhat larger proportion of clay than elsewhere, good farms have been opened and potatoes, oats, rye and grasses are staple crops. Most of this soil formation, however, is too coarse and porous to be considered fertile. It seems best adapted to light farming and grazing.

COLBY LOAMY CLAY.

Area. This soil formation has a greater extent than any other soil formation within the area of the map. It covers the western and northern portions of Marathon and adjoining portions of Lincoln and Langlade, southern Taylor, most of Clark and the northern half of Wood counties. Outside the area of this map it extends westward across the state, covering large portions of southern Chippewa, Eau Claire, Dunn, St. Croix and Pierce counties.

Surface Features. The surface of this formation is gently rolling. In general the surface is similar to that of the Marathon loam, a view of which is presented in Fig. 1, Plate VI, opposite page 40. In northeastern Clark County is a broad upland area with low slopes. Throughout central Wood County, also, the land is gently sloping with here and there a hill rising above this lower surface. Everywhere there are good surface drainage slopes. Swamps, lakes, or ponds are nowhere found in the area of this soil. In only rare instances are the slopes too steep for cultivation, such conditions being confined to the vicinity of the river rapids or on the side of some of the hills of sandstone and granite in Wood and Clark counties.

Character and Origin. The surface soils of this formation are clays and clayey loams quite uniform in texture and composition. In general it is the heaviest soil of the area. It is the weathered product of the mass of ground-up rock left upon the surface of this part of the state during the early periods of the Great Ice Age. This glacial debris varies in thickness from less than a foot to upward of 150 feet. This great difference in thickness is due in part to the unevenness of the land before the glaciers advanced over it; in part to the unequal distribution of the drift during the forward movement of the glaciers; and in part to the fact that certain portions of the area have been covered by more than one of the earlier drift sheets.

This soil formation being of glacial origin, a few boulders or "hard heads" are found in the surface loams. However, boulders in the soils of the old drifts are strikingly less abundant than in the newer drift soils further north and east. The general absence of boulders in the old drift soils is in part at least due to their disintegration and breaking up into soils through the processes of rock weathering during the long period which has elapsed since these old drift formations were deposited. For a similar reason, there are no lakes, basins, or swamps in the area of this soil formation. The drift has been exposed to the erosion and wash by streams and rains for such a long period that the depressions have either been drained by streams or have been filled by the wash of rains from the adjoining hill sides.

The depth at which the drift has weathered to appropriate material for soils varies from one or two feet up to 10 or 15 feet. The surface 6 to 10 inches is enriched with abundant decayed organic material. The portion below this is grayish clay mixed with quartz. Where the drift is less than 10 or 15 feet thick the crystalline rock, which is the usual formation lying beneath, is weathered into clay and quartz, in character similar to the subsoil of the Marathon loam.

The deep weathering of these old drift formations forming the Colby clay soils makes them of especial value to agriculture. Similar soil conditions prevail here as upon the old drift formations which constitute the richest agricultural regions of southern Iowa, northern Missouri, and northeastern Kansas.

Ground Water. While the surface is generally rolling and a large portion of the precipitation flows off from the surface, yet the fine texture of these soils is strongly conducive to the retention of sufficient rainfall as it sinks into the ground to supply the necessary moisture and food for plant growth. In those smaller areas where the slope of the surface is slight the soil is likely to remain wet and cold during the rainy seasons, but as the lands about become cleared better surface drainage will be established and the fertility of these cold soils will gradually be increased, as in all older settled countries, until they even surpass in richness the more readily drained fields. The nearly level areas of the formation in the central portion of Wood County usually lie upon the sandstone and they also have a greater content of sand in their composition and hence have a better under drainage and are slightly warmer than those soils of the thicker drift overlying the crystalline rock farther north.

In order to obtain abundant well water in the area of this formation it is usually necessary to penetrate the drift formation to the underlying rock beneath. This is partly explained at least by the fact that the streams of the area of this soil are bottomed in bed rock. This soil formation overlies the granite and other crystalline rock in Marathon and the adjoining portions of Taylor, Lincoln, and Langlade counties. In eastern Clark and northern Wood, both the sandstone and crystalline formations form the underlying rock, the sandstone becoming more abundant to the southwest and almost entirely replacing the crystallines in southern Wood and southern and western Clark. But whether the bed rock is the crystalline or sandstone formation, if the drift is about 15 feet or more in thickness, abundant water is usually found at the contact or a short distance below. Where the drift is thin the underlying rock must be penetrated to a variable but not great depth, depending much upon the slope of the land and elevation above the stream beds. A noteworthy example showing the truth of the above general statements concerning wells in the thick drift is illustrated by the well data collected along the broad ridge of thickly settled country extending from Marshfield through Lynn to Neillsville, where the drift formation is from 60 to over 160 feet deep, and notably thicker than elsewhere, and into which the wells penetrate, with few exceptions, to the underlying rock beneath, which is generally sandstone.

Forest Growth. The forest trees of this soil formed a good growth, mainly of hard woods and hemlock, with which was sprinkled a plentiful growth of large white pine along the streams. The pine, with few exceptions, has been wholly cut away. Hemlock is an abundant and thrifty growth in northern Wood, northeastern Clark counties and farther to the east and north. The hard woods are birch, basswood, elm, maple, ash, and oak, the latter being more abundant in Wood and Clark counties.

Crops. The clay soils of this formation constitute throughout good strong land, very productive and durable. Because of its good drainage, every acre of it can be utilized for farm crops, and it gives every promise of being equal to the best and richest agricultural portions of the state or of the northwest. All farm crops succeed well. Grass and clover is an abundant crop, and dairying and stock-raising is wisely becoming the chief source of the farm income. The small grains, corn, and potatoes can readily be grown and should be raised in rotation with the feeding crops for dairy stock, sheep, and swine. Small fruits and garden truck are easily grown, and upon well selected sites the hardier fruit trees can be grown with some success.

MARATHON LOAM.

Area. The area of the Marathon loam is within the south central portion of Marathon County and the adjoining portion of Portage County. As shown by the map, it includes the whole or portions of the towns of Wausau, Easton, Weston, Kronenwetter, Knowlton, Maine, Stettin, Rib Falls, Cassel, Marathon, Emmett, Bergen in Marathon County, and the principal portions of Eau Pleine and Stevens Point in Portage County.

Surface Features. The surface is characterized by rolling country, in sharp contrast with the level sandy bottom lands along the Wisconsin River. The uplands rise to approximately the same elevation and most of them have broad, nearly level tops. The valleys are numerous and have gently sloping sides and in only rare cases are they too steep for cultivation (see Fig. 1, Plate VI). Rib Hill and the other white quartzite hills a few miles southwest of Wausau have ridge-like and pointed tops and rise above the level of the gently sloping and flat topped hills.

Character and Origin. The surface of the Marathon loam is a clayey loam, mixed with a variable amount of small rock fragments. The subsoil is usually a reddish more tenacious clay also containing many minute fragments like the surface portion as well as larger angular fragments of the country rock. The soil and subsoil is generally from one to five feet deep and rests upon the hard crystalline rock of the region. The surface soil is not so heavy or so sticky as the clay soils of the old drift, such as the Colby loamy clay, and hence more readily allows the permeation of air and water. The soil is a type of residual soil, being derived almost entirely from the decomposition of the granite, greenstone, and other crystalline rock lying beneath. These rocks being fine grained to medium in texture, their weathering has produced a clay and loam. The relation of the soil and subsoil to the underlying rock is shown in the photograph, Fig. 2, Plate VI. In places the surface of this soil is covered with a small amount of gravel and scattered boulders, but over most of the area foreign material is entirely absent or so thin that the number of transported pebbles and rock fragments can readily be counted as one drives along the highway. Because of the wash by rains and the slow downhill movement of the soil, by gravity, the soil is deeper on the lower slopes of the valley sides and upon the nearly flat lying summits of the uplands than upon the narrow crests or along the sides of the hills. In

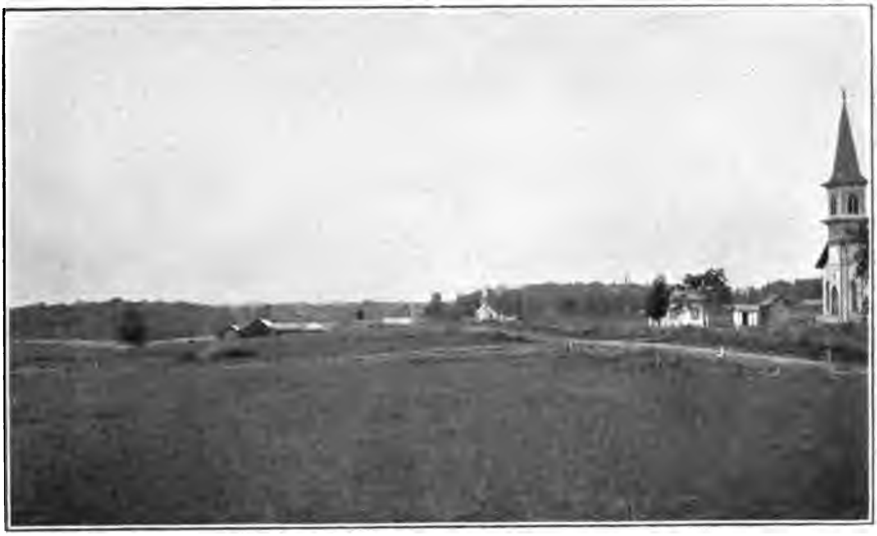


FIG. 1. VIEW OF MARATHON LOAM. TYPE OF RESIDUAL SOIL.
Nine miles northwest of Wausau, Marathon County. View shows sloping surface characterizing this soil formation overlying the crystalline rocks.

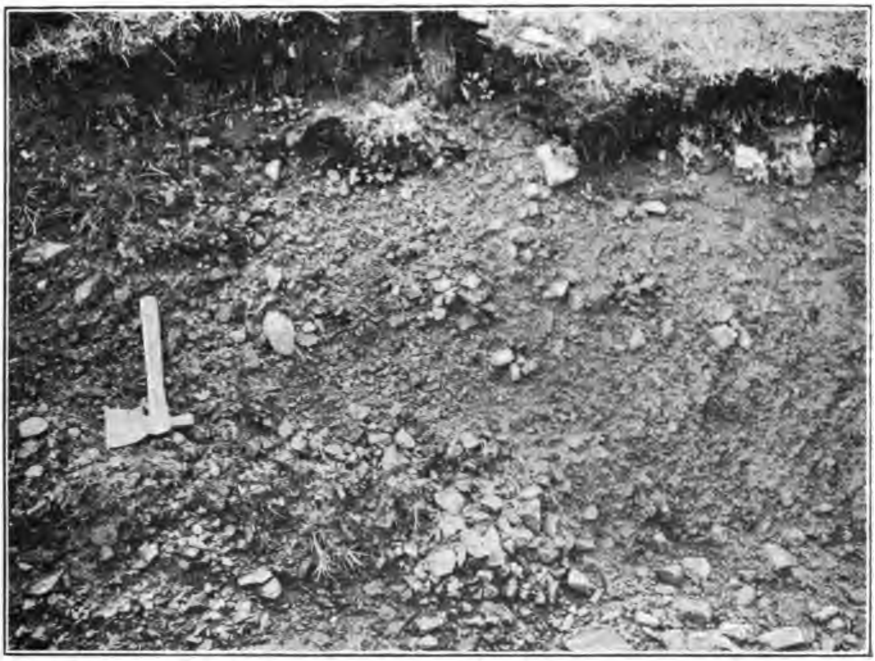


FIG. 2. SECTION OF MARATHON LOAM. TYPE OF RESIDUAL SOIL.
Six miles northwest of Wausau. View shows five to eight inches of surface soil overlying three feet of subsoil consisting of clay and rock fragments grading into the crystalline rock.

general, however, the country is so gently rolling that the washing away of this surface soil by rain is slight. The plentiful scattering of rock fragments throughout the soil furnishes a very important protection against the wash by rain. It should be borne in mind, however, by those who reside within the area of this residual loam that the washing away of the soil from this rolling country does take place slowly and incessantly, year after year, and that every precaution should be observed to restrain this natural process of soil removal, or at least not to assist in the process by shaping conditions favorable to it. This loam formed during centuries of weathering of the crystalline rock is one of the most fertile soils of this area, or of the state. It is also the one of generally least thickness, as may readily be seen by anyone riding along the highways of the area and noting in many places the protruding rock in the bottom of the ditches on either side of the graded road bed. There will be some wash even upon the most gentle slopes. But on the steeper valley slopes special care to prevent wash should be observed. The loam was sufficiently protected so long as the forests and native vegetation grew upon it, but since the land has been exposed to plowing and agriculture, the tendency for soil erosion has been greatly increased.

Ground Water. The ground water available for wells in this formation is not in the soil formation itself as a rule but in the cracks and fissures of the underlying crystalline rock. Much of the rain that falls upon this formation flows off from the surface, but much of it is also taken in by the soil and allowed to slowly percolate to the rocks beneath. The condition of the ground water in this residual soil area is well illustrated in the vicinity of northwest corner of section 27 in the town of Stettin. In this vicinity where the land surface is 200 feet above the valley bottoms of the Big Rib River two miles to the south and the Little Rib River two and one-half miles to the northeast the wells are from 22 to 40 feet deep. A mile farther west in the vicinity of Stettin postoffice where the land is at the same elevation, there are several wells with abundant water the year around which are less than 20 feet in depth. The depths of wells in this formation range generally from 15 to 40 feet, most of them being from 20 to 30 feet deep. Springs are common along the sides and bottoms of the valleys. The depth at which the ground water completely fills the openings in the crystalline rock is thus never far below the surface and sufficient well water is easily obtained. Drilled wells must be made much deeper than dug wells because fewer fractures and crevices are opened and a slower percolation of water into the wells takes place. From what could be learned the level of ground water in this formation has changed but little, if any, since cultivation began.

As the surface soil and subsoil contains an abundance of clay the rainfall percolates slowly and a sufficient quantity of moisture is retained for the growth of crops. Not only is the soil of such character as to retain the moisture but the rocks beneath also hold up the level of the ground water within reach of the surface soil by means of capillary movement. Hence while the land surface of this soil formation is rolling and hilly the texture of the soil and the nearness and abundance of ground water furnish excellent conditions for supplying moisture for the growth of crops.

Forest Growth. The forest trees that grew upon this formation were dense growths of hardwoods and hemlock, with scattered large white pine. The pine is nearly all cut. Much of the hardwoods still remain and consist of birch, basswood and elm, with smaller amounts of oak and maple.

Crops. The clay loam overlying the crystalline rocks is one of the most fertile soils of the region, and can compare with any of the soils of the Mississippi Valley. It is adapted to the successful growth of all the farm crops of Wisconsin or the Northwest. On account of the climate and rainfall it seems best adapted to dairying and stock raising. Grasses and clover have a thrifty growth and are well protected during the winter months by a sufficient snowfall. Oats, barley, corn and potatoes can readily be grown in rotation with the grasses and clover. The thrifty condition of dairying is well shown by the numerous creameries and cheese factories found throughout the area. Garden vegetables and small fruits have an excellent growth. This formation, on account of its good drainage and soil, is also one of the best in this region for the growth of fruit trees. By selecting appropriate sites on the summits of the uplands or upon the north or northeast slopes, the hardier varieties of the apple, cherry and plum can be successfully grown for home use if proper care is observed.

MOSINEE GRAVELLY SOIL.

Area. This gravelly soil formation is very small compared with the other soil formations of the area. The area includes a portion of the town of Mosinee, and adjoining portions of the towns of Marathon and Weston, of Marathon County. A small area, covering several square miles, lies in the town of Harrison, in the northeast corner of the county.

Surface Features. The surface of this formation is uneven and gently sloping and very similar to the surface of the Marathon loam area.

Character and Origin. This soil consists generally of a thin layer of sandy loam containing considerable organic material overlying disintegrated or "rotten" granite and grading down within 5 or 10 feet into the hard, coarse granite. The surface soil is often not more than one or two inches in thickness, and is immediately underlain by the loose and coarse crystals of quartz and feldspar formed by the disintegration of the coarse granite. The soil formation, being formed from the disintegration of the underlying hard rock, has an origin exactly similar to that of the Marathon loam. However, there is a marked difference in the character of the rocks underlying the two soil formations. The crystalline rocks underlying the Marathon loam are fine grained and well adapted to holding water, so that progressive weathering and soil development can readily take place. The coarse granite underlying the Mosinee soil disintegrates into loose, coarse crystals of quartz and feldspar which are generally from one-fourth to one-half inch in diameter. It appears that the granite of this formation is too coarse to produce a good soil. Wherever these coarse granites occur, therefore, only a thin surface soil overlying several feet of coarse rotten granite has been developed. In small patches within the area of this formation, however, where the fine grained crystallines occur or in bottoms where soil has been washed in, a good rich soil has been formed.

Ground Water. The ground water is of very uncertain quantity in this formation. On account of the proximity of the hard granite to the surface and its usual massive and solid character, water veins are not very abundant in it. The rain readily sinks through the thin surface soil and gravelly subsoil and on account of the sloping character of the land readily finds its way beneath the surface to the adjoining streams.

Forest Growth. Despite the coarseness of this soil formation, a dense growth of hardwoods, hemlock and white pine has thriven upon it. The pine has been wholly cut away. Much of the the hardwoods, consisting mainly of birch and maple, and the hemlock, still covers a very large portion of the formation. The abundant growth of hardwoods upon this peculiarly coarse formation is due to the long and penetrating roots of the trees which are able to reach out for long distances in all directions for the purpose of obtaining moisture.

Crops. This soil is generally too coarse and open in texture to produce most farm crops successfully. In certain parts of the area where the underlying rock is not the coarse granite, a good, rich soil like the Marathon loam is found, and where this occurs the usual crops of the latter formation can be grown. Where the clayey portion of the soil overlying the coarse formation is from 5 to 12 inches thick, or more, potatoes and corn can readily be grown; but where the surface soil is but a few inches thick it is better not plowed or disturbed at all, but left to the growth of grass and clover for pasture land.

ACKLEY GRAVELLY CLAY.

In the western half of the town of Ackley, Langlade County, and adjoining portions of the town of Hewitt and Harrison of Marathon County, is a broad, nearly flat lying area here referred to as the Ackley gravelly clay. This area has a soil differing in many important respects from that of the region immediately surrounding. This area is outlined only in a general way on account of the lack of roads through it, and other difficulties of traversing it. The area is nearly flat lying though sloping gently to the southwest. The soil is a gravelly clay, generally called "hard pan," grading quickly down into disintegrated granite, which is the prevailing rock, at and near the surface. The original forest growth in this area was sparse. Ground water generally stands near the surface and surface drainage is slow. No farms have been opened in this area.

SWAMP AND MARSH SOIL.

Area. The distribution of swamp and marsh lands is mainly confined to the northern part of the area, and in the southeastern and southern part. A large part of Marathon and Clark counties and northern Wood is wholly free from swamp and marsh lands. The area of the swamps and marshes is, with very few exceptions, confined to the area of the latest drift formation and to the area of the outwash plains connected with the latest drift along and adjacent to the Wisconsin River and some of its tributaries. While wet lands were originally present where the old drifts and residual soils occur, these were generally stocked with hardwood and had a slow natural surface drainage and hence have readily passed under cultivation as the woods were cleared and the lands adjacent opened up for settlement. In the area of the newer drift sheets, however, where ponds, lakes, and depressions occur, natural surface drainage is wanting and swamps occur which under natural conditions and without artificial drainage will remain wet for a long time.

Surface Features. The surface of the swamps and marshes, of course, is approximately flat and level. Indeed, it is principally this flatness, causing a lack of surface drainage, which keeps them in the wet and marshy condition.

General Character and Origin. In a general way two kinds of swamps may be distinguished in the area, one kind being the generally small swamp associated with lakes and depressions in the hilly drift of the northern and eastern part of the area which is generally stocked with tamarack and cedar; and the other, the large marshy tracts in southern Wood and Portage counties which never possessed a heavy stock of timber but was quite generally covered with scattered tamarack, marsh grass, sedge and cranberry. While some of the swamps in the northern part of the area are also often without timber and are covered with a growth of moss and cranberry and the marshes of Portage and Wood in places are covered with a sparse growth of tamarack, yet the prevailing type associated with the hilly drift is the wooded swamp, and that of the alluvial plains in Wood and Portage is the open marsh.

The surface soils of all the swamps are quite generally a mixture of clay and humus, often called muck and peat. The peat has been formed from the growth and accumulations of sphagnum moss and other plants and generally varies from a few inches to 10 or 15 feet in thickness. Because of repeated fires but little of the peat in some of the swamps is left.

The subsoils of the swamps in the northern part of the area consist of a mixture of clay, sand and boulders and gravel like the material of the adjacent wooded lands of the Chelsea soil formation. The subsoil of the large open marshes in Portage and Wood counties is a variable thickness of loosely stratified gravel and sand like that of the Bancroft soil.

Ground Water. The water standing in the swamps and marshes is sometimes above and sometimes at the level of the ground water of the surrounding land. All marshes and swamps, without exception, are bottomed with layers of clay or peat or other impervious material which holds the water up and prevents downward percolation. Water loving plants like the moss and sedge then spring up and prevent evaporation and hinder the run off of the rainfall. It very often happens that the burning of the impervious peat beds through repeated forest fires allows the water to percolate to lower levels and thus removes the cause of the swampy condition. Sometimes, as above stated, the marsh waters are approximately on a level with the underground water of the surrounding higher lands. Examples of this were the large cranberry marshes in southern Portage and Wood counties under conditions existing twenty or thirty years ago. But at present the ground water of the adjacent higher land has been lowered from ten to twenty feet by cultivation and the cranberry marshes now require much more irrigation than drainage.

Forest Growth. The forest and herbaceous growth developed upon the swamp and marsh soils has already been generally referred to. The swamp timber is generally tamarack and cedar, with lesser amounts of spruce and some white ash. The herbaceous growths common over the large marshes in Portage and Wood county are the marsh grasses and sedges, various mosses, and the cranberry.

Crops. The swamp lands of northern Wisconsin are in general much dryer than they were when the country was first opened to agriculture. This change has been brought about by a combination of causes due to cultivation and the consequent gradual lowering of the level of the ground water and to forest fires. The drying of the swamp lands can be greatly increased by removing the forest covering of the swamps, clearing the surface of accumulated debris, and digging drainage ditches. As the swamp lands become sufficiently dry and the humus or peat is not too abundant, the ordinary crops of the area can be grown upon them.

In the undrained and wet condition, the marshes of Portage and Wood counties are mainly used for the production of wild hay, and to a considerable extent in Wood County for the culture of the cranberry. The best condition for the growth of the cranberry crop in this vicinity appears to be an impervious bottom bed of peat, for holding a layer of water in which the cranberry grows. Other necessary conditions are facilities for complete control so that the marsh can be readily drained or irrigated as needed. In 1899, according to the United States Census, 1,766 acres were devoted to cranberry culture in Wood County with a production of 34,176 bushels. In the production of cranberries Wisconsin ranks third among the states of the Union, and Wood County the sixth among the counties of the Union. In recent years some of the marsh lands west of Babcock in southern Wood County have been devoted to the raising of coarse native grass and sedge, called "wire grass" which is used largely in manufacturing mats and furniture.

CHAPTER III.

CLIMATE AND PRECIPITATION, HISTORY AND AGRICULTURAL CONDITIONS.

CLIMATE AND RAINFALL.

The weather conditions of the area are modified appreciably by the two great lakes, Superior and Michigan, within 75 miles to the north and east. Neither of these lakes freezes over in the winter, and because of their large area, 32,000 and 22,400 square miles, it is evident that whenever winter winds come from their direction, both their temperature and humidity are increased. In like manner during the summer months, the lakes tend to make the air cooler whenever the winds come from the lakes, for the body of Lake Superior very rarely reaches a temperature much greater than 46° F., and much the same conditions hold for Lake Michigan. While it is true that the prevailing winds are from a westerly quarter, yet changes due to the location of storm centers to the west and southwest cause the air to flow in from the lakes and thus appreciably temper the winds.

Temperature. For the purpose of showing the temperature conditions of the area two tables (Tables I. and II.) have been arranged. One table includes the months of April to September, the growing season of the year, and the other table the months of the non-growing season. The period covered is the past ten years, from 1892 to 1901, inclusive, so far as possible, and the data is compiled from the published and unpublished work of the U. S. Weather Bureau. Koepenick, Langlade County, is located 15 miles north of Antigo, just outside the area of this report.

TABLE I.—*Table of Mean Maximum, Mean Minimum and Mean Monthly Temperatures, in degrees Fahrenheit, for the growing season for ten years, from 1892 to 1901.*

			APRIL.			MAY.			JUNE.			JULY.			AUGUST.			SEPTEMBER.		
STATION.	COUNTY.	Elevation above Sea Level. feet.	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly
Amherst[1]……….	Portage…….	1,200	75.4	17.0	44.6	83.2	29 0	55.4	91.7	37.1	66.0	94.0	43.5	70.6	92 0	40.8	67.9	89.8	25.9	59.9
Stevens Point[2]…	Portage…….	1,113	78 0	16.4	46.5	85.6	29.7	57.7	83.0	38.4	67.3	96.2	43.7	70.7	93.0	40.2	68.2	90.3	26.4	60.4
Neillsville …….	Clark………	…..	77.0	16.2	45.3	84.1	28.8	55.9	91.6	36.1	66.3	94.0	41.6	69.9	91.8	39.2	67.5	88.3	26.2	59.3
Medford[3]……….	Taylor……..	1,420	76.3	10.0	42.6	86.3	24.0	53.7	93.6	33.2	65.6	99.1	38.2	69.5	96.1	36.4	67.5	92.1	24.5	58.6
Koepenick[4]…….	Langlade ….	1,683	74.9	17.7	44.0	84.9	33.0	53.9	90.1	42.8	66.2	92.3	51.4	68.7	89.0	49.0	65.0	84.8	36.0	59.7

[1] Amherst lacks records for May, 1901, August, 1901, September, 1901.

[2] Stevens Point records do not extend back to 1892, and January, 1893.

[3] Medford lacks June, 1899.

[4] Koepenick lacks April, 1901, and maximum and minimum for May, 1896.

TABLE II.—*Table of Mean Maximum, Mean Minimum and Mean Monthly Temperatures, in degrees Fahrenheit, for the non-growing season for ten years, from 1892 to 1901.*

			OCTOBER.			NOVEMBER.			DECEMBER.			JANUARY.			FEBRUARY.			MARCH.		
STATION.	COUNTY.	Elevation above Sea Level. feet.	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly	Mean Maximum	Mean Minimum	Mean Monthly
Amherst..........	Portage.......	1,200	77.5	19.1	47.4	59.8	-1.3	30.1	46.2	-13.5	18.7	42.7	-19.4	13.9	43.7	-22.2	14.0	55.9	-7.7	26.1
Stevens Point[1]....	Portage	1,113	79.1	19.3	48.5	63.3	-2.7	30.9	45.0	-13.8	19.2	44.6	-21.3	15.9	44.3	-25.1	12.4	55.7	-8.3	26.5
Neillsville[2].......	Clark.........	.....	76.8	17.9	47.5	59.9	-2.4	29.5	43.0	-17.8	17.7	42.0	-25.7	12.8	43.2	-27.1	13.4	57.1	-11.7	25.95
Medford...........	Taylor........	1,420	77.6	16.1	46.3	61.2	-5.5	27.8	46.6	-20.0	16.5	42.6	-28.2	11.5	47.3	-27.7	12.6	45.8	-16.5	23.7
Koepenick[3].......	Langlade	1,683	73.8	22.2	46.5	62.9	2.7	30.5	42.7	-16.0	16.0	44.0	-21.3	12.1	47.7	-22.9	11.9	51.8	-8.7	24.4

---

[1] **Stevens Point lacks records for 1892, and maximum temperature for October and November, 1901, January, 1893.**

[2] **Neillsville lacks October and November, 1901.**

[3] **Koepenick lacks October, November, December, 1900, and January, February, March, 1901.**

By a study of the temperatures for the growing season of the year, valuable information may be obtained concerning the possibility of successfully growing tobacco, corn, pease and other crops not at present grown extensively in the area. The table of temperatures for the non-growing season gives a correct statement concerning what may be expected in the various portions of the area for the winter months of the year.

Rainfall. The table of monthly rainfall or precipitation (Table III.), shows the average monthly and annual rainfall in inches for the past ten years for each of the stations.

TABLE III.[1]—*Table of mean monthly pricipitation in inches for the period of ten years, from 1892 to 1901.*

Month.	Amherst.	Stevens Point.	Neillsville.	Medford.	Koepenick
January	1.26	0.83	1.13	1.08	1.28
February	1.29	0.64	1.27	1.09	1.18
March	1.77	1.49	2.25	1.38	1.75
April	2.81	2.57	3.15	2.12	2.76
May	3.97	3.52	4.15	4.03	3.51
June	4.27	3.96	4.86	5.20	3.79
July	3.27	3.47	3.77	4.04	3.79
August	2.44	2.20	2.91	2.86	2.99
September	3.12	3.59	3.35	3.41	3.54
October	2.99	2.96	3.23	3.75	3.71
November	1.57	1.35	1.71	1.29	1.89
December	1.30	0.92	1.34	1.03	0.95
Annual	30.06	27.50	33.12	31.28	31.14

[1] Compiled from reports of U. S. Weather Bureau.

It will be seen that for the area Neillsville receives the largest average annual amount of rainfall, 33.12 inches, and Stevens Point the smallest amount, 27.50 inches, and the other stations receive intermediate amounts. From the table it may also be seen that the amount of rainfall for the growing season, April to September, inclusive, for the several stations, is as follows:

Amherst	19.88 inches
Stevens Point	19.31 inches
Neillsville	22.19 inches
Medford	21.60 inches
Koepenick	20.38 inches

The amount of rainfall for the growing season is therefore equal to about two-thirds of the annual precipitation, and approximately double the amount for the non-growing season. Thus the rainfall is exceptionally well distributed, the largest rainfall coming in those months when vegetation is greatest in need of it, and during the autumn and winter months when crops are at rest the climate is dry, healthy, and invigorating.

Comparing the rainfall conditions of Wisconsin with those of the adjoining states, it may be seen, as shown by Professor F. H. King[1] that the general averages stand about as follows:

	Winter.	Spring.	Summer.	Autumn.	Mean.
Wisconsin	4.7 in.	7.6 in.	11.7 in.	8.3 in.	32.3 in.
Illinois	7.2 in.	9.8 in.	11.4 in.	9.2 in.	37.6 in.
Iowa	4.0 in.	8.6 in.	12.5 in.	7.9 in.	33.0 in.
Minnesota	2.7 in.	6.4 in.	11.2 in.	5.9 in.	26.2 in.
Southern Michigan	7.0 in.	7.8 in.	10.1 in.	9.2 in.	31.1 in.

---

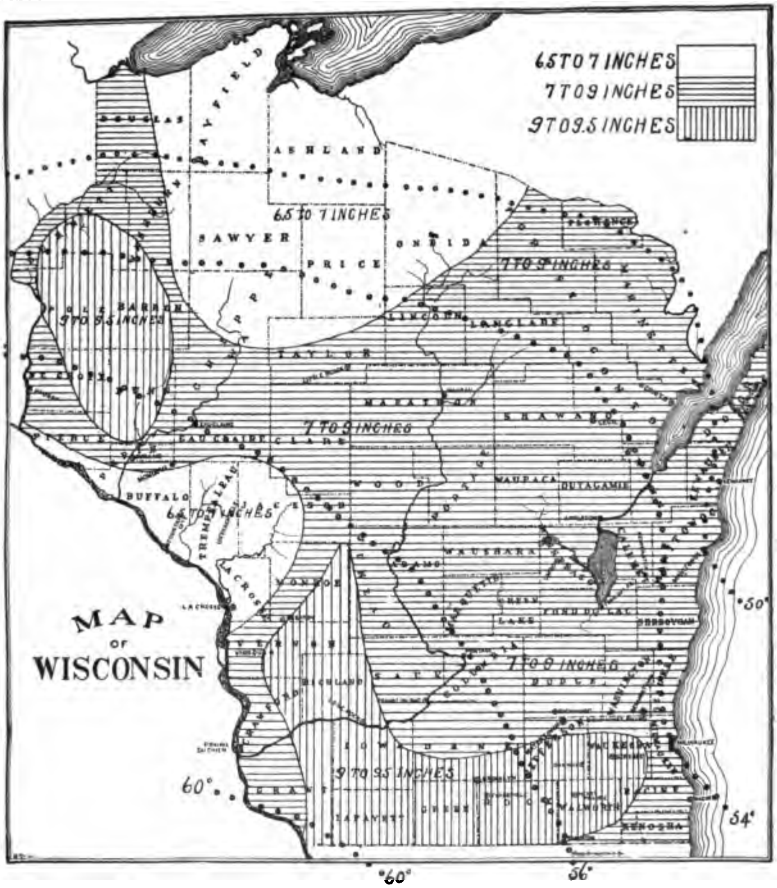
[1] Northern Wisconsin, A Handbook for the Homeseeker, p. 38.

TABLE IV.[1]—*Table of last and first killing frosts, for ten years, from 1892 to 1901.*

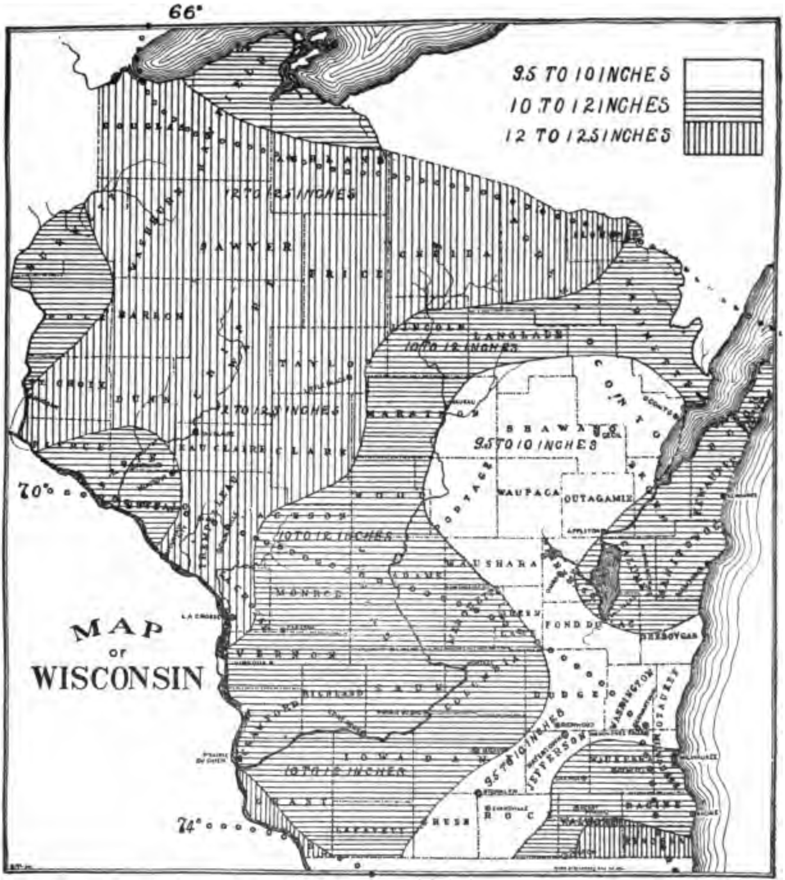
YEAR.	Amherst, Portage County.		Stevens Point, Portage County.		Neillsville, Clark County.		Medford, Taylor County.		Wausau, Marathon County.		Koepenick, Langlade County.	
1892..............	May 15	Sept. 6	....	....	....	....	....	....	....	....	....	....
1893..............	May 8	Sept. 25	May 8	Sept. 24	May 28	Aug. 29	May 28	Sept. 24	....	....	May 6	Sept. 24
1894..............	June 5	Sept. 12	June 6	Sept. 25	June 6	Aug. 3	June 6	Sept. 11	....	....	July 20	Aug. 20
1895..............	May 27	Sept. 30	July 9	Sept. 1	July 9	Sept. 30	June 29	Aug. 21	....	....	May 26	Sept. 30
1896..............	Apr. 10	Sept. 22	Apr. 22	Sept. 20	Apr. 22	Sept. 20	Apr. 22	Sept. 20	Apr. 22	Sept. 22	Apr. 22	Sept. 20
1897..............	June 1	Sept. 20	June 1	Sept. 20	June 1	Sept. 20	June 8	Sept. 17	June 6	Sept. 20	June 1	Sept. 20
1898..............	May 6	Sept. 10	Apr. 27	Sept. 9	Apr. 29	June 11	May 7	Sept. 9	Apr. 29	Sept. 11	....	Oct. 13
1899..............	May 14	Sept. 13	May 31	Sept. 14	May 4	Sept. 20	May 13	Sept. 13	May 13	Sept. 15	....	....
1900..............	May 9	Oct. 15	....	Oct. 18	May 9	Oct. 17	June 30	Sept. 17	May 19	Oct. 17	May 2	....
1901..............	....	....	May 25	Oct. 3	June 1	Oct. 18	June 8	Oct. 3	....	Oct. 3	June 1	....

---

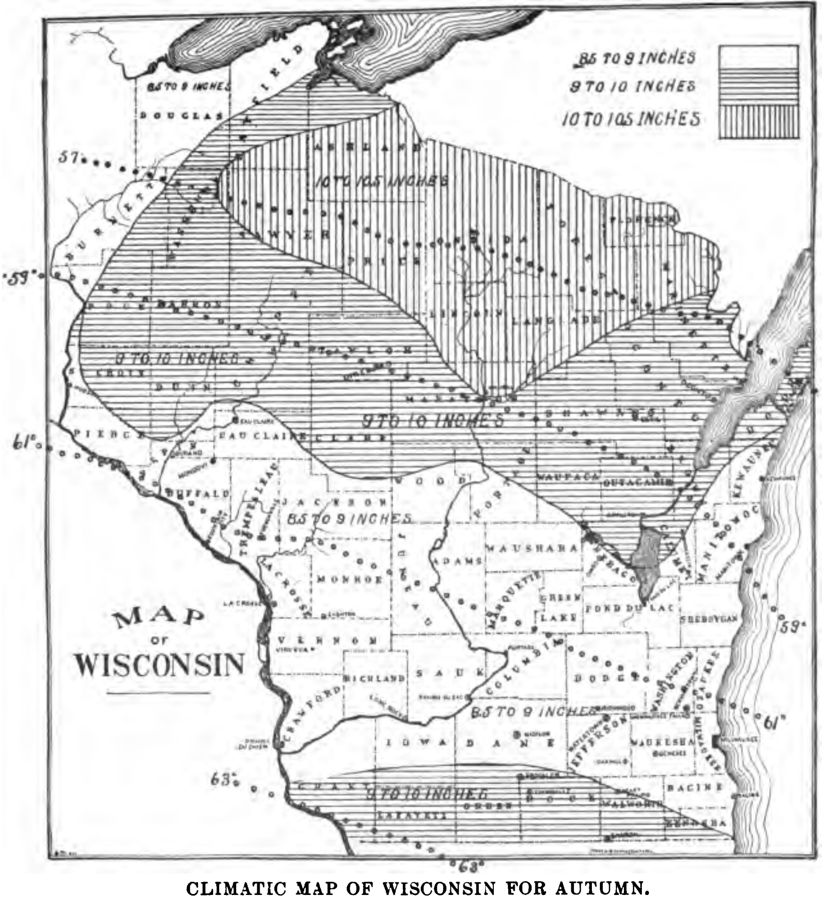
[1] Compiled from Reports of U. S. Weather Bureau.



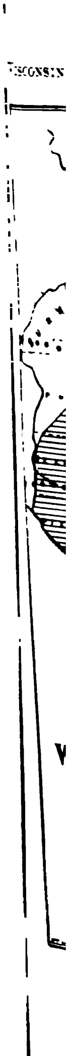
CLIMATIC MAP OF WISCONSIN FOR SPRING.
Mean temperature for May, and the mean precipitation for March, April and May.
(Plates VII to X are after F. H. King in the Handbook of Northern Wisconsin.)



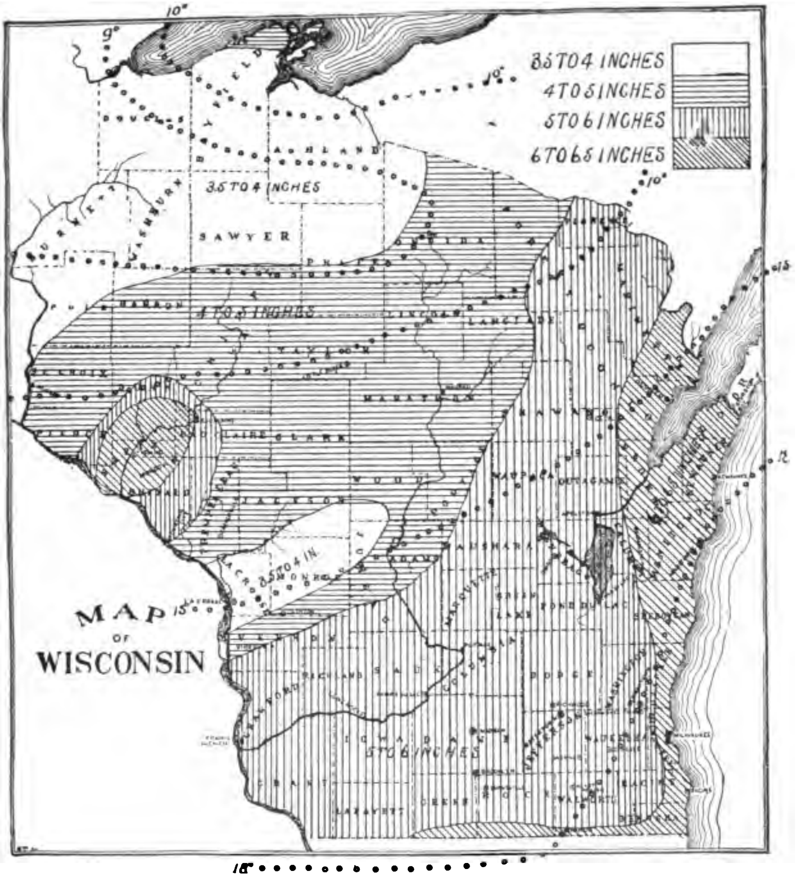
CLIMATIC MAP OF WISCONSIN FOR SUMMER.
Mean temperature for July, and the mean precipitation for June, July and August.



CLIMATIC MAP OF WISCONSIN FOR AUTUMN.
Mean temperature for September, and the mean precipitation for September, October and November.



SCONSIN



CLIMATIC MAP OF WISCONSIN FOR WINTER.

Mean temperature for January, and the mean precipitation for December, January and February.

From this table it will be seen that Wisconsin has more rain in the summer months, June, July, and August, when crops are most in need of it, than either of the other states except Iowa. The total rainfall for the whole year is considerably greater than that of Minnesota, almost equal to that of Iowa and southern Michigan, and appreciably less than that of Illinois.

Killing Frosts. Killing frosts occur in this area as late as May and June, but not to such an extent as to be at all discouraging to agriculture in most of its phases. In general, frosts are not earlier in the autumn than for the southern portions of the state, northern Illinois, or Iowa, though they are likely to occur later in the spring. The table of last and first frosts (Table IV.) shows what has occurred at the various stations during the past decade, so far as the records extend.

The above tables of temperature and precipitation for the several stations furnish the latest information concerning these important factors in agriculture for the area above described. In the charts of the state (Plates VII to X) showing the temperature and rainfall for each of the seasons during the period of twenty-five years from 1870 to 1895 the general condition for the whole state is graphically presented. It should be borne in mind by the reader that the condition of the soil is only one factor in the problem of agriculture and that conditions of temperature and amount of rainfall especially for the growing season are also of great importance. These latter named factors cannot be controlled by the farmer like that of the soil, as exemplified in his choice of soil and his method of tillage and hence the kind of crop proposed to be raised should be especially studied with respect to its climatic requirements. Results in growing new crops are usually learned by the slow and often costly method of individual experimentation. A knowledge of the existing climatic and soil conditions and comparison with the known conditions under which the same crop has been grown in other localities should guide the farmer a long way in his growing of new crops.

In the matter of a larger development along already well established lines of agriculture, such as dairying, climatic conditions are especially important. In the dairying industry a comparison of the climate of the northern counties with the southern portions of the state and with other dairying sections of the country shows the northern counties of the state to be especially favored. Throughout the growing season of the year, in the area here described, there is a sufficient fall of rain to cause a continuous growth of nutritive grass for grazing purposes, and the climate is sufficiently cool to produce the best flavored milk, a highly important factor in making the best grade of butter and especially important in the production of the best flavored varieties of cheese.

HISTORY.

This area, with the adjoining portions of northern Wisconsin, was originally covered with a dense growth of hardwoods and pine, the latter being especially abundant and of large growth along the sandy lands of the river bottoms. It was the pine which first attracted settlers to northern Wisconsin, just as about a decade earlier the lead mines began to draw settlers to southern Wisconsin. The pioneer lumbermen came in from the south, following up the natural highways of the Wisconsin and Black rivers. At first the pine was exported as logs by floating or driving them down the river in log rafts. Later as saw mills were erected at the numerous river rapids of the region the pine was sawed and driven down in lumber rafts. As the railroads penetrated the area river exportation gradually gave way to the more rapid shipment by rail. Wherever sawmills were erected villages sprang up and, following the location of the permanent mill settlements, the clearing of farms began. For a number of years the principal interest of the people was in the lumber industry. Steadily and rapidly, however, the change was wrought by which agriculture supplanted lumbering as the leading industry of the area.

First Settlements. The first permanent settlement[1] in Wood county, and also within this area, was made at Whitney's Rapids, the present site of Nekoosa, in 1831–32, where a sawmill was erected. The first sawmill erected within the present site of Grand Rapids was in 1838, and the first school was here established in 1842–3. Less than 30 people, it is recorded, were living in Portage county in 1840. Stevens Point was first settled about 1843, and the first farm is said to have been cleared there in 1845. Wausau was first settled in 1845 and Merrill in 1847. The first settlement in Clark County is said to have been on the present site of Neillsville, in 1845, and the first farm laid out there in 1850. Taylor County appears to have received no permanent settlers until the Wisconsin Central Railroad reached it in 1873.

First Railroads. The Wisconsin Central Railroad reached Stevens Point in 1871, and Prentice, Price County, in 1873. The Wisconsin Valley Railroad, now the Chicago, Milwaukee & St. Paul, reached Grand Rapids in 1873, Wausau in 1874, and Merrill in 1881. The Chicago, St. Paul, Minneapolis & Omaha Railroad entered Neillsville in 1881.

Increase of Population. The growth of population in the six whole counties of the area since 1860 is shown in the following table:

TABLE V.[2]—*Population from 1860 to 1900.*

County.	1860.	1870.	1880.	1890.	1900.
Portage	7,507	10.634	17,731	24,798	29,483
Wood	2,425	3,912	8,981	18,127	25,868
Clark	789	3,450	10,715	17,708	25,845
Marathon	2,892	5,885	17,121	30,360	43,256
Taylor	....	....	2,311	6,731	11,262
Lincoln	....	....	685	9,465	12,553
Total	13,613	23,881	57,644	107,198	148,267

---

[1] Historical data compiled from "History of Northern Wisconsin," 1881.

[2] Compiled from Table 4, Vol. I, Twelfth Census of the United States, 1900.

CONDITION OF AGRICULTURE.

Certain portions of the area are well settled, the first clearings dating back about 40 or 45 years. Other portions of the area, though having in general equally as good soils, are still covered with dense hardwood and hemlock forests. As one passes over the area, therefore, rapid changes are often met with, from towns dotted with well cleared farms, with large and well equipped farm buildings, to bordering areas of pioneer settlements and then to the unbroken forest. The map of the area showing the roads and houses expresses clearly and accurately the distribution of the settled and unsettled portions of the area. The map shows the central and southern parts of the area much more opened up to agriculture than the northern part, though large portions of the southern half also still remain unimproved.

Proportion of Cultivated and Uncultivated Lands. The following table (Table VI.), gives the total area of land and also the lands under cultivation in thousands of acres, in 1895 and 1900, for the several whole counties of the area.

TABLE VI.—*Total land and cultivated land in 1895 and 1900.*

County.	Total land area (in 1,000 acres).	Cultivated land in 1895, in 1,000 acres. (State census.)	Cultivated land in 1900, in 1,000 acres. (U. S. census.)
Clark	778	82	120
Lincoln	572	9	23
Marathon	1,007	104	145
Portage	523	142	189
Taylor	632	15	23
Wood	515	53	91

The following table gives the total number of farms in the six whole counties of the area, also the farms with buildings, the total and improved acres in the farms, and the average size of farms:

TABLE VII.[1]—*Number of farms and acres in farms in 1900.*

COUNTIES.	NUMBER OF FARMS.		ACRES IN FARMS.		Average size.
	Total.	With buildings.	Total.	Improved.	
Clark	3,456	3,355	325,755	120,964	94.3
Lincoln	924	876	98,933	23,317	107.1
Marathon	4,276	4,207	442,878	145,060	103.6
Portage	3,172	3,116	393,857	189,396	124.0
Taylor	1,168	1,157	103,565	23,392	88.7
Wood	2,359	2,266	271,537	91,966	115.1

[1] Compiled from Tables 10 and 19, Vol. V, Twelfth Census United States, 1900.

The farms vary widely in size, but generally range between 20 acres and 200 acres.

Farm Buildings. New settlers generally begin wisely by building their first houses and barns of logs. Later, as the farms are cleared, more pretentious buildings are constructed, which resemble those of all other portions of the northern states. The second barn is generally the typical stone-basement barn, the basement being wholly used for the stabling of stock, and the upper story built of wood, painted red, and having threshing floor and haymows.

The dwelling houses in the older sections are well built and comfortable and are usually frame structures, although a large and growing percentage of the newer houses are made of brick. Stone houses are rare or entirely wanting in the area. Because of the nearness to the lumber market, the cost of farm buildings is relatively much less than in the prairie or older settled portions of the Northwest.

Price of Farm Lands. Dividing the values of the farm lands without buildings, shown in Table VIII, by the total acres in farms, shown in Table VII, for each of the counties the average price per acre of farm lands can be obtained. Farm values, however, in central and northern Wisconsin, have appreciably increased in the last two years, since the last census was taken. Farm lands without improvements and with little or no merchantable timber generally vary, at present (1903), from $5 to $15 per acre, depending upon accessibility by rail and wagon road as well as upon fertility of soil. In the southern part of the area higher prices prevail than in the northern part. Improved lands generally sell for $30 to $50 per acre, not considering value of farm buildings.

TABLE VIII.[1]— *Table showing value of farm property and live stock June 1, 1900, value of products not fed to live stock in 1899, value of all dairy products in 1899, and expenditures for fertilizers in 1899.*

COUNTY.	VALUE OF FARM PROPERTY, JUNE 1, 1900.				Value of products in 1899 not fed to live stock.	Value of all dairy products, 1899.	Expended in 1899 for fertilizers.
	Land and improvements except buildi'gs	Buildings.	Implements and machinery.	Live stock.			
Clark	$3,376,800	$2,011,460	$479,300	$1,463,104	$1,304,210	$305,484	$1,510
Lincoln	1,045,640	334,670	91,810	252,311	398,298	63,393	660
Marathon	6,328,210	2,253,170	497,820	1,609,238	1,713,544	282,272	10,120
Portage	5,305,400	1,809,120	405,700	1,056,934	1,450,132	258,281	4,690
Taylor	1,127,030	444,400	105,860	305,781	305,056	58,232	220
Wood	3,909,710	1,234,440	273,210	782,398	795,164	167,897	940

---

[1] Compiled from Tables 19 and 44, Vol. V, Twelfth Census of the United States, 1900.

TABLE IX.[1]—*Table showing acreage and production of the six cereals in 1899.*

	Barley.		Buck-wheat.		Corn.		Oats.		Rye.		Wheat.	
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
Clark	1,923	48,040	718	10,350	6,141	193,690	21,096	793,510	4,363	81,200	3,608	60,020
Lincoln	385	7,380	46	780	170	6,790	3,590	93,770	511	8,880	553	8,530
Marathon ..	4,797	107,310	268	3,200	2,671	89,690	31,666	847,890	6,182	97,460	8,125	113,590
Portage....	421	7,530	983	9,270	17,289	388,100	31,878	734,070	20,409	217,780	6,373	85,910
Taylor	401	8,350	20	270	91	2,990	2,328	63,940	1,048	20,070	309	4,370
Wood.......	1,754	42,500	832	8,920	4,763	105,070	11,829	331,740	5,417	72,830	2,289	34,240

Live Stock and Animal Products. The value of live stock and dairy products for each of the counties is shown in Tables VIII. The sale of live stock and dairy products is the principal source of farm revenue in all the counties with the possible exception of Portage in which the potato crop is a very important source. Wisconsin is one of the leading five states in the Union in the value and production of dairy products and northern Wisconsin is especially well adapted to this industry. Dairying has been growing rapidly in the northern counties during the past decade and wisely so. The principal sales of live stock are of neat cattle, sheep, and swine.

Crops. In the appended tables X and IX a statement of the common crops in the six whole counties of the area is given. In the statement concerning the hay crop only the hay made from clover and timothy with other tame grasses is given. All the important common crops, as should be expected, are grown in the area. Hay is the leading crop with oats second in all the counties except Portage in which potatoes is first and hay second. The crops of Portage county, where sandy loams prevail, are quite different from those of the other counties where clay loams occur. Wheat and rye are more important crops than corn in Marathon, Lincoln, and Taylor, rye is more important than corn in Portage and Wood, but in Clark corn is more important than either rye or wheat. The sandy loam prevailing throughout Portage County has caused much greater special farming in this county than in the other counties of the area. The especially important crop in Portage is the potato crop. Among the states Wisconsin ranks second in the production of potatoes and Portage County first in Wisconsin and fourth among the counties of the Union. In the production of rye Wisconsin ranks first among the states and Portage County fifth among the counties of the state and twelfth among the counties of the Union. The production of pease in Marathon and Clark is probably now much less than in 1899 and the production of corn has greatly increased.

---

[1] Tables IX and X compiled from Table 55, Vol. VI, Part II, Twelfth Census United States, 1900.

TABLE X.—*Table showing acreage and production of tame hay potatoes, beans and peas in 1899.*

	CLOVER.		TIMOTHY AND OTHER TAME GRASSES.		POTATOES.		BEANS.		PEAS.	
	Acres.	Tons.	Acres.	Tons.	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
Clark	790	1,746	39,356	61,605	2,637	267,769	152	1,399	2,935	47,422
Lincoln...............	222	369	8,844	11,006	742	77,768	11	147	307	4,286
Marathon...........	1,339	2,544	47,746	65,904	5,004	450,989	92	1,202	4,512	65,033
Portage.............	12,502	16,677	16,113	18,193	29,099	1,978,344	43	379	417	6,608
Taylor	112	187	10,157	14,295	916	82,780	19	242	460	6,441
Wood	611	1,005	20,620	28,072	4,169	273,625	158	1,110	1,010	15,365

In addition to the crops already mentioned, all kinds of garden truck are grown and also the common small fruits, such as strawberry, raspberry, blackberry, currant and gooseberry. Each of these fruits is native throughout northern Wisconsin, which proves their adaptability to the soil and climate. The large fruits, such as apple, pear, plum, and cherry are less successful, but if a wise selection of soil and site is made, the hardier varieties of the apple, plum, and cherry may be grown with fair success. The cranberry is an important crop in the irrigated peat soils of southern Wood County.

Transportation and Communication. Each of the counties of the area is well supplied with railroads, affording ample means of transportation to the Chicago and Milwaukee markets. Telephone lines reach every village and most country stores, and rural mail routes are gradually being placed throughout the area. In the settled portions of the area good roads prevail, it being the general policy of the road authorities to construct graded roads to all new settlers as fast as possible. In some of the older sections macadam and gravel roads have been built. The toll system is nowhere in vogue in the area.

Local Markets. The leading cities, with their population in 1900, are as follows:

Wausau	12,354
Stevens Point	9,524
Merrill	8,537
Marshfield	5,240
Antigo	5,145
Grand Rapids	4,493
Tomahawk	2,291
Neillsville	2,104
Medford	1,758

Smaller cities and villages are well distributed throughout the area and afford ample means for trade.

Forest Conditions. The standing timber in millions of feet, board measure, in 1897, was estimated by F. Roth of the U. S. Dept. of Agriculture to be as follows:

County.	Pine.	Hemlock.	Hardwood.
Clark	200	30	650
Portage	20	50	100
Marathon	200	1,500	1,500
Lincoln	250	1,000	1,000
Taylor	200	1,500	1,000
Wood	100	40	300

The pine is mostly white pine, only a very small percentage being Norway. Much less than one-half the pine is in large bodies, the rest occurring thinly scattered through the hardwoods and hemlock. The hardwoods consist of ash, basswood, birch, elm, oak and maple. The above estimates were carefully made in 1897, and it is probable that 50 to 75 per cent. of the pine, and 10 to 20 per cent. of the hardwoods and hemlock have since been cut.

INDEX.

Ackley gravelly clay, described, 44-45.
Ackley, town of, 22, 44.
Acres in farms, 59.
Agriculture, condition of, in North Central Wisconsin, 58.
Alban, postoffice, town of, 26.
Alluvial sand and gravel, wells in, 9.
Almond, village of, 9, 21, 22.
  town of, 25.
Amherst sandy loam, described, 25-28.
Amherst, town of, 25.
  village of, monthly precipitation in, 52.
    maximum and minimum temperature in, 50-51.
    summer rainfall in, 53.
    killing frosts in, 54.
Animal products, 61.
Antigo, city of, 2, 7, 9, 28.
  population of, 63.
Antigo gravelly loam, described, 22-24.
Area, of Amherst sandy loam, 25.
  of Antigo gravelly loam, 22.
  of Bancroft gravelly sandy loam, 20.
  of Cary sandy loam, 30.
  of Chelsea clay loam, 28.
  of Colby loamy clay, 36.
  of Harrison sandy gravelly soil, 35.
  of Kennan clay loam, 33.
  of Marathon loam, 39.
  of Mentor loamy sand, 32.
  of Mosinee gravelly soil, 43.
  of North Central Wisconsin, 1.
  of swamps and marsh soil, 45.
  of Wisconsin River sandy soil, 17.
Arnott, village of, 21.
Arpin, village of, 2.
Artesian wells, absence of, 11.

Babcock, village of, 48.
Bancroft, village of, 20, 21, 22.
Bancroft gravelly sandy loam, described, 20-22.
Belmont, town of, 25.
Bergen, town of, 39.
Big Eau Pleine River, 3.
Big Rib River, 41.
Black River, 3, 56.
Brick clays, 7.
Buena Vista, town of, 25.

Cary sandy loam, described, 30-32.
Cary, town of, 31.
Cassel, town of, 39.
Chamberlin, T. C., referred to, 12.
Character and origin, of Amherst sandy loam, 25.
  of Antigo gravelly loam, 22.
  of Bancroft gravelly sandy loam, 20.
  of Cary sandy loam, 31.
  of Chelsea clay loam, 29.
  of Colby loamy clay, 36.
  of Harrison sandy gravelly soil, 35.
  of Kennan clay loam, 34.
  of Marathon loam, 40.
  of Mentor loamy sand, 32.
  of Mosinee gravelly soil, 43.
  of swamp and marsh soil, 45.
  of Wisconsin River sandy soil, 17.
Chelsea clay loam, described, 28-30.
Chemical composition of soil, 16.
Chippewa River, 3.
Claud's Lake, 25.
Classification of soil, 15.
Climate, 49.
Colby loamy clay, described, 36-39.
Composition of soil, chemical, 16.
  textural, 15.
Condition of agriculture, 58.
Condition of rainfall, 53.
Copper River, 3.
Crops, of Northern Central Wisconsin, statistical tables of, 61-63.
  of Amherst sandy loam, 27.
  of Antigo gravelly loam, 24.
  of Bancroft gravelly sandy loam, 21.
  of Cary sandy loam, 31.
  of Chelsea clay loam, 30.
  of Colby loamy clay, 39.
  of Harrison sandy gravelly soil, 36.
  of Kennan clay loam, 34.
  of Marathon loam, 42.
  of Mentor loamy sand, 33
  of Mosinee gravelly soil, 44.

Crops, of swamp and marsh soil, 47.
  of Wisconsin River sandy soil, 19.
Cranberry, culture of, 47.
  in Wood County, 63.
Crystalline rocks, described, 4.
  wells in, 9.

Dexter, town of, 31.

Easton, town of, 39.
Eaton, town of, 31.
Eau Claire River, 3, 22.
Eau Pleine, town of, 40.
Elevation of North Central Wisconsin, 1.
  of Rib Hill, 2.
  of Power's Bluff, 2.
Ellis postoffice, 20, 21.
Emmett, town of, 39.
Expenditures for farm property, 60.

Farm lands, 59.
Farm property, 60.
Farms, acres in, 59.
  average size of, 59.
  number of, 59.
Farm buildings, 59.
Fertilizers, 60.
Forest condition, 64.
Forest growth, of Amherst sandy loam, 27.
  of Antigo gravelly loam, 24.
  of Bancroft gravelly sandy loam, 21.
  of Cary sandy loam, 32.
  of Chelsea clay loam, 30.
  of Colby loamy clay, 39.
  of Harrison sandy gravelly soil, 35.
  of Kennan clay loam, 34.
  of Marathon loam, 42.
  of Mentor loamy sand, 33.
  of Mosinee gravelly soil, 44.
  of swamp and marsh soil, 47.
  of Wisconsin River, sandy soil 19.
Frosts, killing, table of, 55.

Glacial drift, described, 5.
  wells in, 9.
Grand Rapids, city of, first settled, 57.
  population of, 63.
Granite, 7.
Ground water, changes in level of, 8.
  of Amherst sandy loam, 26.
  of Antigo gravelly loam, 24.
  of Bancroft gravelly sandy loam, 21.
  of Cary sandy loam, 31.
  of Chelsea clay loam, 30.
  of Colby loamy clay, 38.
  of Harrison sandy gravelly soil, 35.
  of Kennan clay loam, 34.
Ground water, of Marathon loam, 41.
  of Mentor loamy sand, 33.
  of Mosinee gravelly soil, 44.
  of swamp and marsh soil, 46.
  of Wisconsin River sandy soil, 18.

Harrison sandy gravelly soil, described, 35-36.
Harrison, town of, in Lincoln county, 35.
  in Marathon county, 43, 44.
Hansen, town of, 31.
Hiles, town of, 31.
Hull, post office, 20.

Jump River, 3.

Kennan clay loam, described, 33-35.
King, F. H., referred to, 15, 18, 19, 53.
King, town of, 35.
Knowlton, town of, 39.
Koepenick, village of, 49.
  monthly precipitation in, 52.
  summer rainfall in, 53.
  temperature in, 51-52.
Kronenwetter, town of, 39.

Lakes and swamps, 3.
Lake Emily, 25.
Lanark, town of, 25.
Lands, proportion of cultivated and uncultivated, 58.
Levis, town of, 31.
Limestone, absence of, 7.
Little Eau Pleine River, 3.
Little Rib River, 41.
Little Wolf River, 27.
Live stock, 61.
  table of value of, 60.
Lynn town of, 31.
  village of, 39.

Maine, town of, 39.
Marathon loan, described, 39-43.
Marathon, town of, 39-43.
Markets, 63.
Marl, 7.
Marshfield, city of, 39.
  population of, 63.
Mead, town of, 31.
Medford, city of, 3.
  population of, 63.
  monthly precipitation in, 52.
  summer rainfall in, 53.
  temperature in, 50-51.
Mentor loamy sand, described, 32-33.
Merrill, city of, first settled, 57.
  population of, 63.

Mill Creek, 3.
Mosinee gravelly soil, described, 43-44.
Mosinee, town of, 43.

Neillsville, city of, referred to, 3, 39.
  first settled, 57.
  monthly precipitation in, 52.
  population of, 63.
  summer rainfall in, 53.
  temperature in, 50-51.
Nekoosa, village of, 18, 57.
New Hope, town of, 25.
New Wood River, 3, 29.

Origin of soil, 13.
  (See Character and origin of the soil formations.)
Ogema, village of, 28.

Peat, 7.
Pickerel Lake, 25.
Pine River, 3.
Plover River, 3.
Population, increase of, in the several counties, 58.
  in the leading cities, 63.
Potsdam sandstone, 5.
  wells in, 9.
Powers' Bluff, 2.
Prairie River, 3, 29.
Prentice, city of, 57.

Railroads, first, 57.
Rainfall, table of, 52.
  condition of. in Wisconsin, 53.
Rib Falls, town of, 39.
Rib Hill, 2, 40.
Rivers and valleys, described, 2,
Road material, 7,
Rock, town of, 31.
Rock and mineral supplies, 7.
Rock weathering, 14.
Rosholt, post office of, 26.

Seif, town of, 31.
Seneca, town of, 31.
Settlements, first, 57.
Sharon, town of, 25.
Sherwood Forest, town of, 31.
Sigel, town of, 31.
Slope and general features, of North Central Wisconsin, 1.
Soil, origin of, 13.
  classification of, 15.
  chemical composition of, 16.
  texture of, 15-16.
Somo River, 3.
Spirit River, 3.
Stettin, town of, 39, 41.
Stevens Point, city of, referred to, 18, 57.
  monthly precipitation in, 52.
  population of, 63.
  summer rainfall in, 53.
  temperature in, 50-51.
  town of, 40.
Stockton, village of, 22.
  town of, 25.
Surface features, of Amherst sandy loam, 25.
  of Antigo gravelly loam, 22.
  of Bancroft gravelly sandy loam, 20.
  of Cary sandy loam, 31.
  of Chelsea clay loam, 28.
  of Colby loamy clay, 36.
  of Harrison sandy gravelly soil, 35.
  of Kennan clay loam, 33.
  of Marathon loam, 40.
  of Mentor loamy sand, 32.
  of Mosinee gravelly soil, 43.
  of swamp and marsh soil, 45.
  of Wisconsin River sandy soil, 17.
Swamp and marsh soil. described, 45-48.
Swamps. (See Lakes and swamps.)

Table, of crops, 61, 62.
  of forest conditions, 64.
  of killing frosts, 55.
  of value of farm property, 60.
  of value of live stock, 60.
Temperature, discussed, 49,
  tables of, 50, 51.
Terminal moraine, 2.
Tomahawk, city of, referred to, 28.
  population of, 63.
  town of, 35.
Tomahawk River, 3.
Topography, of North Central Wisconsin, described, 1, 4.
  (See Surface features.)
Transportation and communication facilities, in North Central Wisconsin, 63.
Trapp River, 3.

Washburn, town of, 31.
Water powers, 12.
Water supply, 8.
Wausau, city of, referred to, 2, 10.
  first settled, 57.
  population of, 63.
  town of, 39.
Weathering of rocks into soil, 14.
Well water, character of, 8.

Wells, artesian, absence of, 11.
  in alluvial sand and gravel, 9.
  in crystalline rock, 9.
  in glacial drift, 9.
  in Potsdam sandstone, 9.
Weston, town of, 39, 43.
Wisconsin River, 2, 6, 11, 29 and 45.
Wisconsin River sandy soil, described, 17-20.
Wood, town of, 31.

Yellow River, 3.

PUBLICATIONS

OF THE

Wisconsin Geological and Natural History Survey.

1. Bulletins.

The publications of the Survey are issued as bulletins, which are numbered consecutively. Each bulletin is independently paged and indexed, no attempt being made to group them in volumes. The bulletins are issued in three series,

A. *Scientific Series.*—The bulletins so designated consist of original contributions to the geology and natural history of the state, which are of scientific interest rather than of economic importance.

B. *Economic Series.*—This series includes those bulletins whose interest is chiefly practical and economic.

C. *Educational Series.*—The bulletins of this series are primarily designed for use by teachers and in the schools.

The following bulletins have been issued:

Bulletin No. I. Economic Series No. 1.

On the Forestry Conditions of Northern Wisconsin. Filibert Roth, Special Agent, United States Department of Agriculture. 1898. Pp. vi., 78; 1 map. Sent on receipt of 10c.

Bulletin No. II. Scientific Series No. 1.

On the Instincts and Habits of the Solitary Wasps. George W. Peckham and Elizabeth G. Peckham. 1898. Pp. iv., 241; 14 plates, of which 2 are colored; 2 figures in the text. Sold at the price of $1.50 in paper and $2.00 bound.

Bulletin No. III. Scientific Series No. 2.

A Contribution to the Geology of the Pre-Cambrian Igneous Rocks of the Fox River Valley, Wisconsin. Samuel Weidman, Ph. D., Assistant Geologist, Wisconsin Geological and Natural History Survey. 1898. Pp. iv., 63; 10 plates; 13 figures in the text. Out of print.

Bulletin No. IV. Economic Series No. 2.

On the Building and Ornamental Stones of Wisconsin. Ernest Robertson Buckley, Ph. D., Assistant Geologist Wisconsin Geological and Natural History Survey. 1898 issued in 1899. Pp. xxvi., 544; 69 plates, of which 7 are colored, and 1 map; 4 figures in the text. Sent on receipt of 30c.

Bulletin No. V. Educational Series No. 1.

The Geography of the Region About Devil's Lake and the Dalles of the Wisconsin, with some notes on its surface geology. Rollin D. Salisbury, A. M., Professor of Geographic Geology, University of Chicago, and Wallace W. Atwood, B. S., Assistant in Geology, University of Chicago. 1900. Pp. x., 151; 38 plates; 47 figures in the text. Sent on receipt of 30c.

Bulletin No. VI. Economic Series No. 3. Second Edition.

Preliminary Report on the Copper-Bearing Rocks of Douglas county, and parts of Washburn and Bayfield Counties, Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1901. Pp. vi., 83; 13 plates. Sent on receipt of 10c.

Bulletin No. VII. Economic Series No. 4.

The Clays and Clay Industries of Wisconsin. Part I. Ernest Robertson Buckley, Ph. D., Geologist, Wisconsin Geological and Natural History Survey. In charge of Economic Geology. 1901. Pp. xii., 304; 55 plates. Sent on receipt of 20c.

Bulletin No. VIII. Educational Series No. 2.

The Lakes of Southeastern Wisconsin. N. M. Fenneman, Ph. D., Professor of General and Geographic Geology, University of Wisconsin. 1902. Pp. xv., 178; 36 plates, 38 figures in the text. Sent (bound) on receipt of 50 cents.

Bulletin No. IX. Economic Series No. 5.

Preliminary Report on the Lead and Zinc Deposits of Southwestern Wisconsin. Ulysses Sherman Grant, Ph D., Professor of Geology, Northwestern University. 1903. Pp. viii, 103; 2 maps, 2 plates, 8 figures in the text. Sent on receipt of 10 cents.

Bulletin No. X. Economic Series No. 6.

Highway Construction in Wisconsin. Ernest Robertson Buckley, Ph. D., State Geologist of Missouri, formerly Geologist, Wisconsin Geological and Natural History Survey. 1903. Pp. xvi, 339; 106 plates, including 26 maps of cities. Sent on receipt of 30 cents.

Bulletin No. XI. Economic Series No. 7.

Preliminary Report on the Soils and Agricultural Conditions of North Central Wisconsin. Samuel Weidman, Ph. D., Geologist, Wisconsin Geological and Natural History Survey. 1903. Pp viii, 67; plates 10, including soil map. Sent, paper bound, without charge, cloth bound, on receipt of 20 cents.

IN PRESS.

Bulletin No. XII. Scientific Series No. 3.

The Plankton of Lake Winnebago and Green Lake. C. Dwight Marsh, A. M., Professor of Biology, Ripon College.

Bulletin No. XIII. Economic Series No. 8.

The Baraboo Iron Bearing District. Samuel Weidman, Ph. D., Geologist, Wisconsin Geological and Natural History Survey.

2. BIENNIAL REPORTS.

The Survey has published three biennial reports, which relate to administrative affairs only and contain no scientific matter.

First Biennial Report of the Commissioners of the Geological and Natural History Survey. 1899. Pp. 31.

Second Biennial Report of the Commissioners of the Geological and Natural History Survey. 1901. Pp. 44.

Third Biennial Report of the Commissioners of the Geological and Natural History Survey. 1903. Pp. 35.

3. HYDROGRAPHIC MAPS.

There have been prepared hydrographic maps of the principal lakes of southern and eastern Wisconsin. This work is in charge of L. S. Smith, Assistant Professor of Topographical Engineering, University of Wisconsin.

The following maps are now ready:

		Size of Plate, Inches.	Scale, Inches per mile.	Contour Interval, Feet.
No. 1.	Lake Geneva	17.5x10.8	2	10
No. 2.	Elkhart Lake	15.5x13.1	5	10
No. 3.	Lake Beulah	22.5x20.0	6	10
No. 4.	Oconomowoc-Waukesha Lakes	29.8x19.1	2	10
No. 5.	The Chain of Lakes, Waupaca	21.7x20.6	6	10
No. 6.	Delavan and Lauderdale Lakes	22.5x16.8	4	10
No. 7.	Green Lake	26.0x17.8	3.2	20
No. 8.	Lake Mendota	23.7x19.5	6	5
No. 9.	Big Cedar Lake	18.0x13.5	2.9	10
No. 10.	Lake Monona	17.6x17.3	4	5

In all of these maps the depth of the lakes is indicated by contour lines, and by tints in all except No. 1. They are sent on receipt of 15 cents each except Nos. 4 and 8, for which 20 cents are required. They may be had either mounted in a manilla cover, or unmounted.

All correspondence relating to the survey should be addressed to

E. A. BIRGE, *Director*,
Madison, Wis.

3 2044 102 947 587